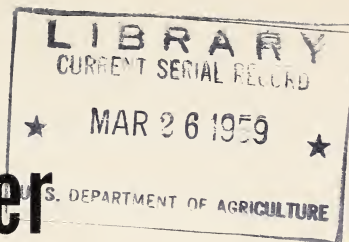


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# Stick Remover for Cotton Gins

By GERALD N. FRANKS  
and C. SCOTT SHAW



Production Research Report No. 22

AGRICULTURAL RESEARCH SERVICE  
UNITED STATES DEPARTMENT OF AGRICULTURE

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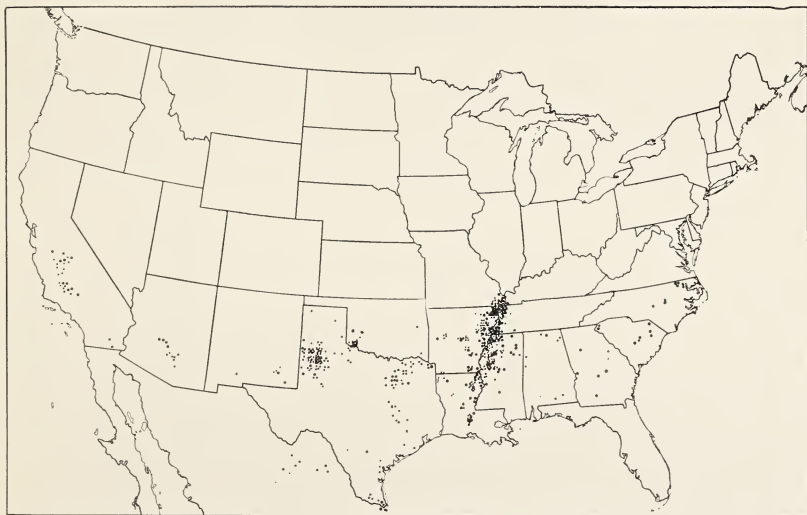
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# STICK REMOVER FOR COTTON GINS

By GERALD N. FRANKS, *agricultural engineer*, and C. SCOTT SHAW, *cotton technologist*, Agricultural Engineering Research Division, Agricultural Research Service

The progressive increase in the use of mechanical cotton pickers and machine strippers, as well as more rough hand harvesting, has intensified the problem of seed-cotton cleaning at gins. Machine strippers in the high-plains areas of Texas and Oklahoma and in other areas have, in many instances, harvested such excessive quantities of sticks and stems along with the cotton that gins could not satisfactorily reclaim the cotton. In some extreme instances, machine-stripped cotton has contained as much as 70 percent of foreign matter. Even in machine-picked cotton—which is generally much cleaner than machine-stripped cotton—the total foreign-matter content sometimes ranges up to 15 or 20 percent in late season, with the stick and stem content alone amounting to several pounds per bale. In such instances the buildup of sticks and stems in the seed rolls of the cotton gins has resulted in lower cotton grades.

As a contribution to better-seed-cotton cleaning, the United States Cotton Ginning Research Laboratories have succeeded in developing a machine that effectively removes sticks and stems along with some other types of foreign matter. Cotton-ginning machinery manufacturers have made wide application of the principle used in this stick remover (fig. 1).



BN-6362

FIGURE 1.—Locations of commercial gins (1956) with cleaning equipment that included use of the stick-remover principle developed by the United States Cotton Ginning Research Laboratories.

## DESCRIPTION

The outstanding feature of the stick remover is the centrifugal principle of extraction. This new application of the multiple-extractor saw-grid principle involves a set of round grid bars, having rather widely spaced openings, located in a concentric position with relation to each saw cylinder. This arrangement facilitates holding the cotton on the revolving saw, and thereby permits acceleration of the seed cotton to the velocity required for effectively expelling the sticks, stems, hulls, leaves, and other foreign matter, with a minimum loss of seed cotton.

The trash, which is slung off through the restraining grid bars by centrifugal force and gravity, does not pass through the incoming stream of seed cotton, as happens when the conventional bur machines and extractors are used. In this new machine, horizontal-saw cylinders, arranged one under the other, are provided with brushes for doffing the cleaned seed cotton from each of the successive cleaning saws. The fourth and final saw is equipped for both reclaiming and cleaning. Its principal function is to reclaim any seed cotton that may have been thrown in with the foreign matter by the three preceding cleaning-saw cylinders. The third cleaning-saw cylinder and the reclaiming-saw cylinder are doffed by the same brush (fig. 2).

Standard 7-inch extractor channel-saw cylinders are used in the stick remover, together with 8-inch doffing brushes. Moderate saw-cylinder speeds of 750 revolutions per minute (r.p.m.) in conjunction with doffing-brush speeds of 1,200 r.p.m. are recommended for the gin-capacity model. Five horsepower is required to operate each 60-inch stick-remover machine, exclusive of separator, feed conveyor, and the fan for handling cotton from the machine.

## EARLY DEVELOPMENTS

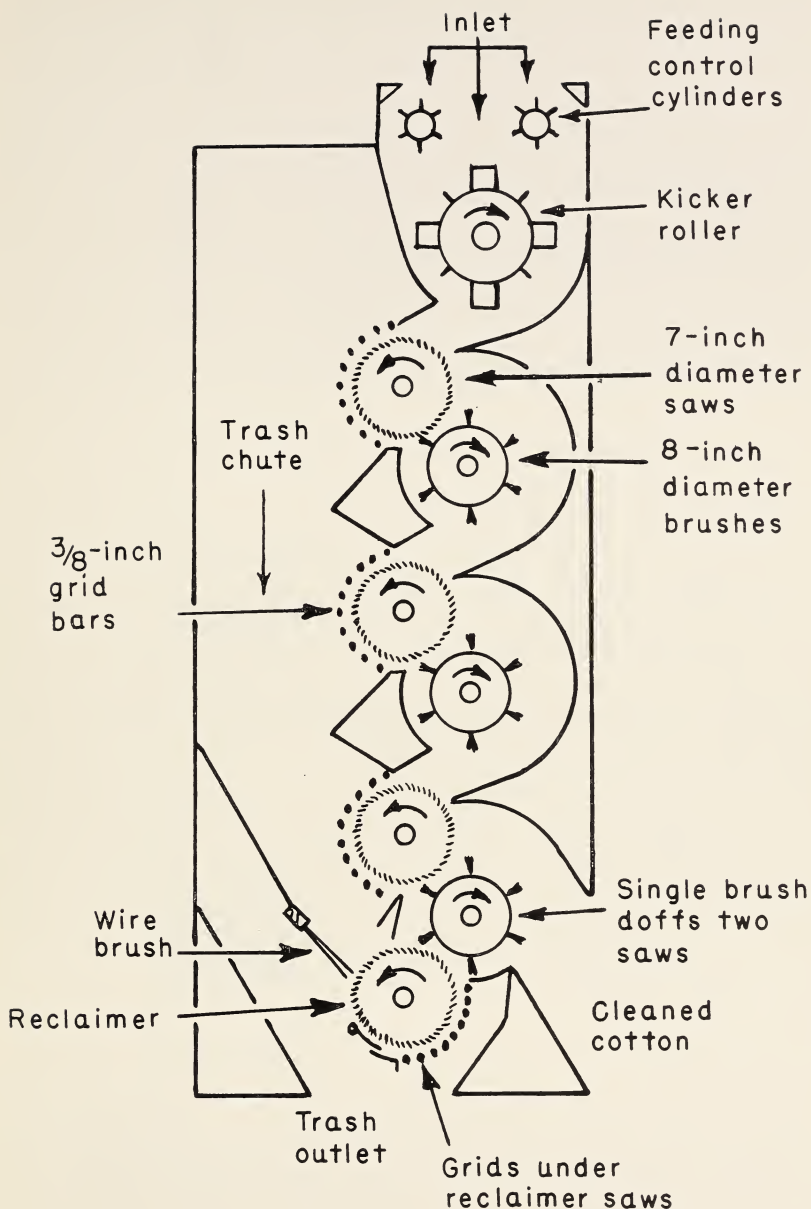
Work toward the development of a satisfactory device for stick removal was started on an intensive scale in 1948 at the U. S. Cotton Ginning Research Laboratory, Stoneville, Miss. Various types of machines were designed, fabricated, and tested.<sup>1</sup> The earlier machines of this project were effective in removing sticks from seed cotton, but they were heavy and complicated. A United States patent dedicated to the public was obtained on one of the machines developed. None of these machines, however, proved to be entirely satisfactory.

In the early part of 1953, special attention was given to the design, construction, and development of a machine that utilized the centrifugal principle of extraction. Rapid progress resulted. A small, simple device, consisting of 2 standard V-belts having sharp-pointed spikes (or nails) that leaned forward and extended approximately  $\frac{3}{4}$  inch above the belt surface, was used first (fig. 3, A). The spikes were set at an angle of about 30° from the belt surface. The 2 belts ran over 2 sets of 2-groove V-pulleys, spaced about 24 inches on center, and were driven at various speeds up to 1,400 feet per minute. Cotton was fed onto the belt surface between the pulleys, and the

---

<sup>1</sup> Project-level responsibility for the engineering phases of the research on the earlier developmental models was assigned to Thomas E. Wright, agricultural engineer, formerly a member of the staff of the U. S. Cotton Ginning Research Laboratory, Stoneville, Miss.

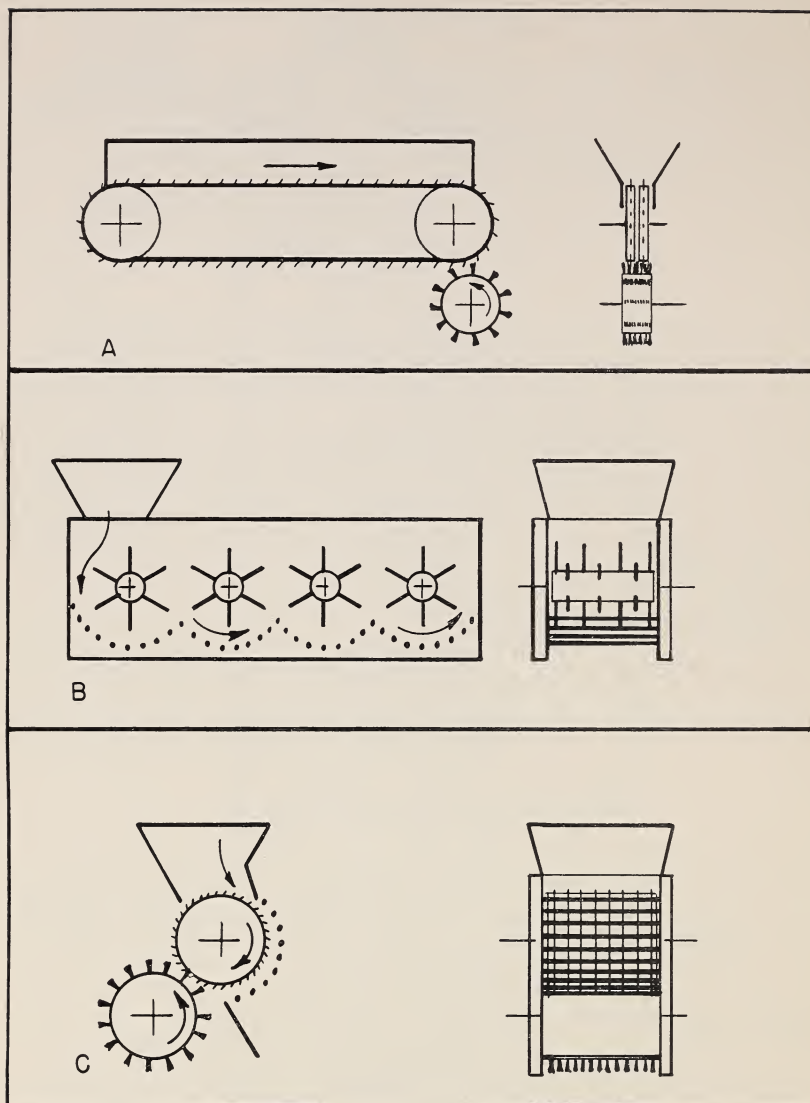




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FIGURE 2.—Cross section of USDA-developed stick remover.

heavy trash was thrown off as the belts made the turn on the small 5-inch pulleys. The cotton was doffed with a revolving brush. The purpose of the work with this device was to determine the effectiveness of the centrifugal-force principle and the optimum speed as related to trash extraction.



BN-6363

FIGURE 3.—Mechanical cleaning devices tried in early development of the stick remover: A, High-speed belt with spikes; B, spiked cylinders and grids; C, channel saws and grids.

After these tests with spiked belts, the screens were removed from a small model of a conventional spiked-drum cleaner having 4 drums, and were replaced by grids made of round  $\frac{3}{8}$ -inch rods (see fig. 3, B). This machine was tried with various spacings between the grid rods and was operated at various drum speeds, until adjustments were reached that gave fair extracting results from the scrubbing action of the seed cotton over the grid slots.



A 7-inch extractor channel saw and doffing brush were then added, to follow the 4 spiked drums. Grid bars were placed concentric to the 7-inch channel-saw cylinder (see fig. 3, *C*). With the addition of the saw cylinder and grid bars, good extraction results were obtained.

Experiments were then performed with trashy cotton, in which only the saw cylinder was used. The use of the saw cylinder alone gave cleaning results equal to those obtained by using the four spiked drums in combination with the saw cylinder. Tests were then repeated with the single saw cylinder by running trashy cotton over it for varied numbers of times. The purpose of these last tests was to determine the number of cleaning-saw cylinders required to fabricate a stick remover that would employ multiple units of the 7-inch channel-saw cylinder in conjunction with the round grid bars and doffing brushes. The test results indicated that four cleaning-saw cylinders would be sufficient.

## PILOT MODEL STICK REMOVER

A more precise, 10-inch-wide pilot model, built on a larger scale, was then constructed. This had four horizontal cleaning-saw cylinders, one over the other, but no reclaimer (fig. 4).

Good results in removing trash, including sticks and stems, were obtained in all tests on this larger pilot model without adverse effects on fiber quality. Machine-stripped, machine-picked, and hand-snapped cottons were used in these tests (figs. 5, 6, and 7). Typical of the early tests run on this pilot model of the 4-cylinder stick remover was one in which the machine was used alone in handling machine-stripped cotton grown in Mississippi. This cotton had a foreign-matter content of 37.6 percent. In this test the stick remover was 88.3 percent efficient in removing hulls, sticks, and stems from the machine-stripped cotton.

Another test in 3 replications was made on early machine-picked cotton having a foreign-matter content of 5.6 percent. The purpose was to gain general preliminary information on the capacity and cleaning effectiveness of the device. The 10-inch pilot model stick remover was used in 2 simple cleaning setups, for comparison with an elaborate cleaning combination consisting of 2 tower driers, a bur machine, and 20 cylinders of overhead cleaning without the stick remover (table 1).

In these tests the grade of the cotton cleaned by the elaborate setup was higher by only one-third of a grade than was that cleaned by the two simple setups in which the stick remover was used. There was no difference in staple length, and no important difference in laboratory fiber-length measurements or in fiber uniformity between the elaborate and the simple setup. However, a higher average nep count in the card web was obtained with the elaborate cleaning-machinery combination than with the 2 simple setups in which the stick remover was used both with and without a 7-cylinder cleaner.

After the initial preliminary tests at the Stoneville laboratory, the 10-inch model (with minor modifications) was taken to the ginning laboratory at Chickasha, Okla., for additional tests (fig. 8). Good results similar to those at Stoneville were obtained at Chickasha. The machine was then returned to Stoneville for further testing and development.

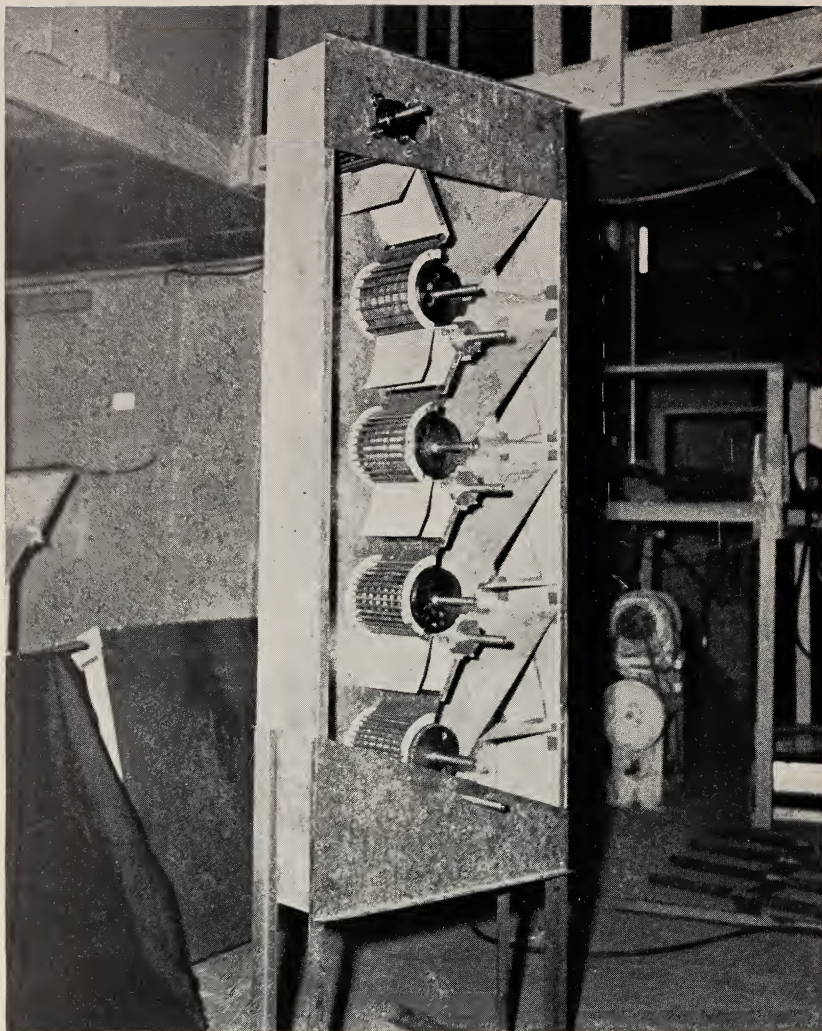


FIGURE 4.—Pilot model stick remover, with side panels and bearing supports removed to show the four 10-inch-long cleaning-saw cylinders.

Capacity data from these tests on the 10-inch pilot model showed that a machine having saw cylinders 60 inches long would effectively clean approximately 50 pounds of machine-picked seed cotton per minute. As a result of these findings, this cleaner was designed to handle cotton at the rate of 50 pounds per minute.

### **DEVELOPMENT OF GIN-CAPACITY STICK REMOVER**

The favorable cleaning and capacity test results obtained with the pilot model fully justified the construction of a 60-inch machine suitable for use in the 3-stand laboratory gin plant (figs. 9 and 10).



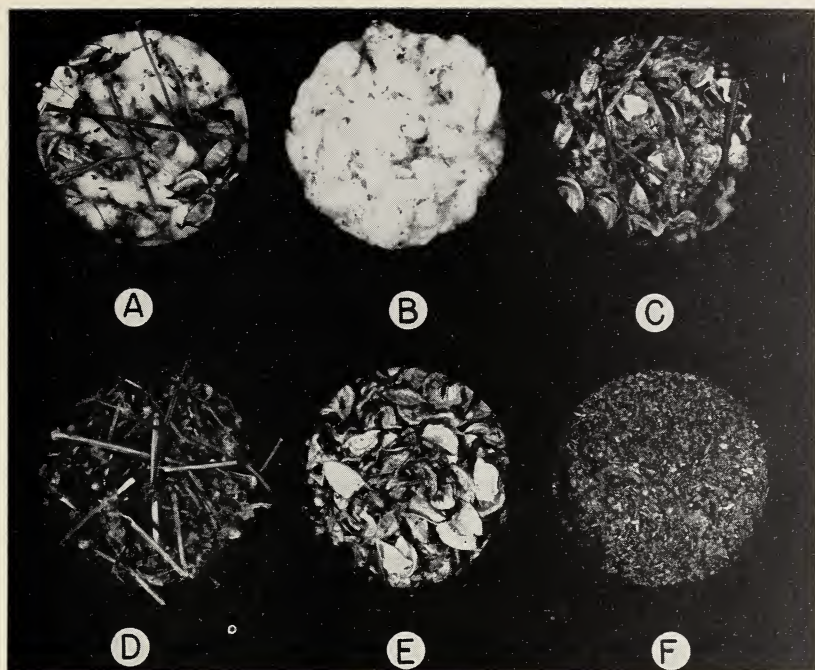


FIGURE 5.—Machine-stripped cotton: *A*, Wagon sample; *B*, seed cotton after leaving stick remover; *C*, trash removed by stick remover; *D*, *E*, and *F*, trash components (sticks and stems, hulls, and fine trash, respectively).

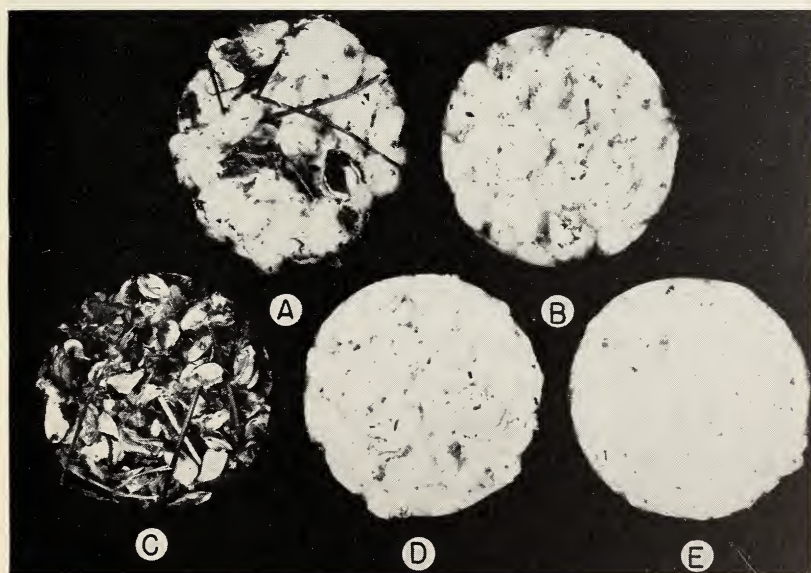


FIGURE 6.—Machine-picked cotton: *A*, Wagon sample; *B*, seed cotton after leaving stick remover; *C*, trash removed by stick remover; *D*, seed cotton after leaving small cleaner-feeder; *E*, lint cotton after leaving plain 20-saw laboratory gin.

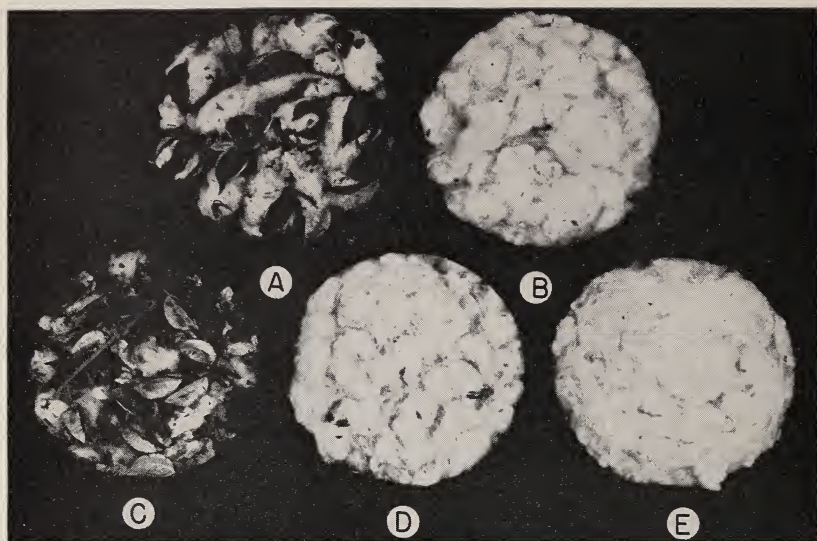


FIGURE 7.—Hand-snapped cotton: A, Wagon sample; B, seed cotton after leaving stick remover; C, trash removed by stick remover; D, seed cotton after leaving small cleaner-feeder; E, lint cotton after leaving plain 20-saw laboratory gin.

TABLE 1.—Results in foreign matter, grade, staple length, fiber data, and nep count, obtained from conditioning cotton with 3 different cleaning-machinery setups (crop of 1953) <sup>1</sup>

Cleaning setup	Foreign-matter content of seed cotton		Grade <sup>2</sup>		Staple length	Fiber data			Neps per 100 square inches of card web
	Wagon sample	Feeder sample				Upper half mean length (fibrograph)	Mean length (fibrograph)	Uniformity ratio	
	Per-cent	Per-cent	Index	Designation	$\frac{1}{32}$ inch	Inches	Inches	Inches	Number
Elaborate <sup>3</sup> ----	5.6	2.3	90.5	SLM—	34.5	1.12	0.86	77	25.3
Simple <sup>4</sup> -----	5.6	2.6	87.0	LM+	34.5	1.14	.87	77	19.3
Very simple <sup>5</sup> ---	5.6	2.8	87.0	LM+	34.5	1.13	.85	75	19.0

<sup>1</sup> Figures represent averages of 3 replications.

<sup>2</sup> 85=LM (Low Middling); 94=SLM (Strict Low Middling).

<sup>3</sup> Elaborate setup: Tower drier at 250° F., 6-cylinder cleaner, big-bur machine, tower drier at 180° F., two 7-cylinder cleaners, extractor-feeders, and lint cleaners.

<sup>4</sup> Simple setup: Tower drier at 250° F., 7-cylinder cleaner, stick remover, and extractor-feeders.

<sup>5</sup> Very simple setup: Tower drier at 250° F., stick remover, and extractor-feeders.





FIGURE 8.—Pilot model stick remover used in tests at Chickasha, Okla.

A 60-inch saw-cylinder length was selected for the large-scale machine as being commensurate with gin-stand width, and also as being the desirable safe-length limit for small diameters from the standpoint of rigidity at high speeds. Inasmuch as satisfactory operating results were obtained with the 60-inch machine at Stoneville, an additional unit was fabricated and shipped to the ginning laboratory at Chickasha, Okla.

After the 60-inch gin-capacity unit was installed in the 3-stand gin plant at Stoneville, a test on machine-picked cotton having an average wagon-sample foreign-matter content of 7 percent was made

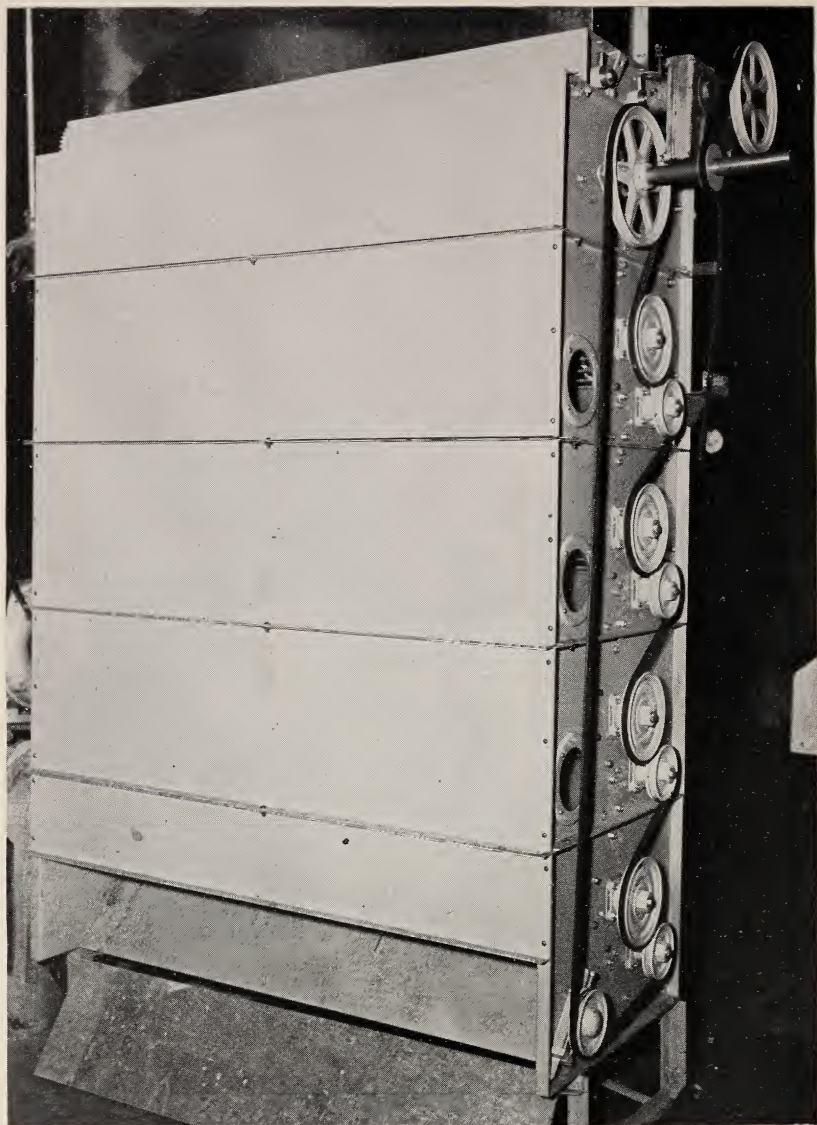


FIGURE 9.—The first 60-inch gin-capacity stick remover, showing serpentine drive.

to obtain information on feed rates, cleaning effectiveness, and cleaning-saw-cylinder speeds. A simple setup was used in which the cotton was passed through the tower drier without heat and the green-boll trap before it reached the stick remover. After the seed cotton was passed through the stick remover, it was passed through only the extractor-feeders before ginning.

In this series of tests, 5 feeding kicker-roller speeds of 400, 450, 500, 550, and 600 revolutions per minute (r. p. m.) were used, respectively, with 5 corresponding cleaning-saw cylinder speeds of 600,



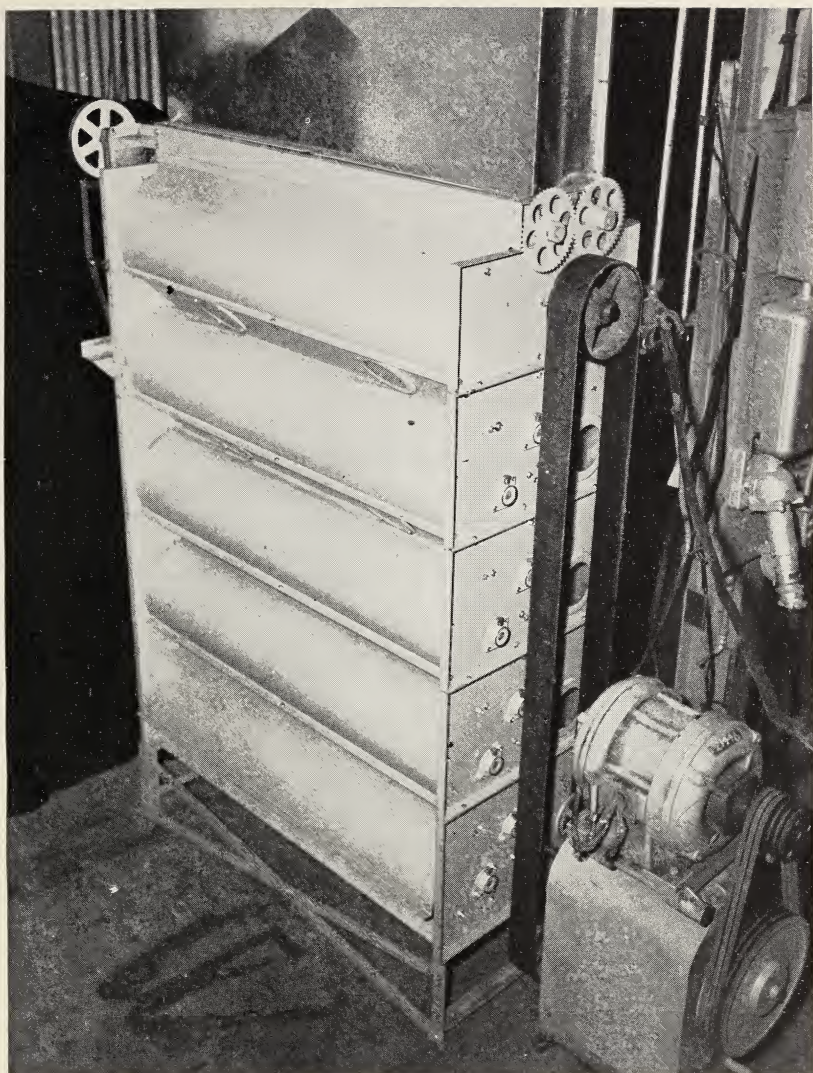


FIGURE 10.—The first 60-inch gin-capacity stick remover, showing observation windows and the contour of the brush scrolls.

675, 750, 825, and 900 r. p. m. The tests were run at 3 rates of feed for each speed combination, involving a total of fifteen 200-pound machine-picked test lots.

Inasmuch as smooth operation without chokage and good cleaning results were obtained when the machine was run at the medium speed of 500 r. p. m. for the feeding kicker-roller in combination with the medium speed of 750 r. p. m. for the cleaning-saw cylinders, these medium-speed settings were selected for future recommended speeds. The total waste removed from the 200-pound lot of seed cotton with these medium-speed settings was 16 pounds, or 2.2 pounds above the

average waste removal obtained with the other 14 speed combinations. The trash-removal results associated with the operation of the stick remover at 5 different saw-cylinder speeds, in handling machine-picked cotton, were converted to a per-bale basis.

The following figures represent averages of three replications. The seed-cotton lots used in the test weighed 200 pounds each. Trash weights were adjusted on the basis of 1,400 pounds of machine-picked seed cotton per bale.

<i>Cleaning-saw-cylinder speeds (r. p. m.)</i>	<i>Total trash extracted by stick remover per bale (pounds)</i>
600	87.5
675	98.0
750	99.4
825	90.3
900	99.4

In these tests the seed-cotton input feed rate was 51 pounds per minute, and the output rate was 49 pounds per minute, for the selected medium speeds. This confirmed earlier observations on capacity in the studies with the 10-inch pilot model machine (see p. 6), which indicated that each 60-inch machine would satisfactorily handle an input of 50 pounds per minute of machine-picked cotton. Higher feed rates were possible with the higher speeds, but increased feeds caused chokages at low speeds.

In this series of tests, a removable trash pan was provided to receive the trash from each of the four cleaning cylinders. This arrangement made it possible to determine the weight of waste material removed by each of these cylinders. These data were used in calculating the percentage of foreign matter removed by each successive cylinder, as compared with the total for the four cylinders combined. The greatest amount of trash was removed by the first cylinder, and the quantity removed thereafter was progressively less for each successive cylinder. This was to be expected, since the trash content of the cotton and its cleaning potential decreases as it moves from one cylinder to the next. The situation is shown by data representing the lot which was passed through the stick remover at the selected medium speeds during this series of tests (tables 2 and 3).

TABLE 2.—*Foreign-matter content of a 1,400-pound bale of machine-picked seed cotton as it was introduced into and passed through the 4 successive cleaning cylinders of the 60-inch stick remover*<sup>1</sup>

Cleaning-cylinder stage	Foreign-matter content	
	<i>Pounds</i>	<i>Percent</i>
Before entering 1st cylinder	98.0	7.0
After leaving 1st cylinder	67.2	4.8
After leaving 2d cylinder	50.4	3.6
After leaving 3d cylinder	42.0	3.0
After leaving 4th cylinder	30.8	2.2
Total foreign matter removed by all 4 cylinders	67.2	68.6

<sup>1</sup> These figures were calculated on the basis of 1,400 pounds of seed cotton per bale from test data on 200-pound lots.

TABLE 3.—*Foreign matter removed from a 1,400-pound bale of machine-picked seed cotton as it passed through the 4 successive cleaning cylinders of the 60-inch stick remover*<sup>1</sup>

Cleaning-cylinder stage	Foreign matter removed	
	Actual amounts	Proportions
	<i>Pounds</i>	<i>Percent</i>
First cylinder-----	33. 9	50. 5
Second cylinder-----	18. 4	27. 4
Third cylinder-----	8. 5	12. 6
Fourth cylinder-----	6. 4	9. 5
Total foreign matter removed by all 4 cylinders-----	67. 2	-----

<sup>1</sup> These figures were calculated on the basis of 1,400 pounds of seed cotton per bale from test data on 200-pound lots.

As previously stated (pp. 9-10), the 15 machine-picked lots in this series of tests were subjected to a simple cleaning-machinery combination consisting of a tower drier without heat, a green-boll trap, a 60-inch stick remover, and extractor-feeders. With this simple setup, a grade of Strict Low Middling plus (SLM+) and a staple length of  $1\frac{3}{32}$  inches were obtained without adverse effects on fiber quality.

A more elaborate cleaning-machinery combination, consisting of 2 tower driers, a bur machine, 18 to 20 cylinders of overhead cleaning, extractor-feeders, and lint cleaners, is usually recommended for handling machine-picked cotton. When such a setup is used on machine-picked cotton having 7 percent foreign-matter content, grades average about Middling (M). It is of special interest, therefore, that the simple setup with the stick remover gave grades that were only about one-third of a grade lower than the average usually obtained with the more elaborate setup recommended for similar machine-picked cotton.

To obtain more information on the maximum capacity of the 60-inch machine with respect to the output delivery to the gin stands, 4 half-bale lots of hand-snapped cotton having a wagon-sample foreign-matter content of 11.9 percent were used. In this test the seed-cotton feed rates were gradually increased for each successive lot until maximum input and output rates of 112.8 and 98.4 pounds per minute, respectively, were reached on the fourth half-bale lot (table 4). For best cleaning results, however, it is recommended that hand-snapped cotton input be held to 50 pounds per minute for each 60-inch machine (table 5).

A simple setup was used for processing the four half-bale lots. This consisted of a tower drier at 220° F., a green-boll trap, a 60-inch stick remover, and extractor-feeders. A grade of Low Middling spot plus (LMSpt+) and a staple length of  $1\frac{1}{16}$  inches were obtained on this late hand-snapped, weather-damaged cotton by means of this simple setup. The foreign-matter content of the lint, as determined by the Shirley Analyzer<sup>2</sup> tests, averaged 5.43 percent. This falls

<sup>2</sup> The mention in this publication of commercially manufactured equipment does not imply its endorsement by the U. S. Department of Agriculture over similar products not named.



TABLE 4.—Capacity data and average quality results obtained in processing 4 half-bale lots of hand-snapped seed cotton through the 60-inch stick remover (crop of 1953)

Capacity data for each lot					Average data for all 4 lots <sup>1</sup>					
Lot number	Weight of lot	Stick remover processing time		Seed-cotton input feed rate	Seed-cotton output feed rate	Foreign-matter content of—			Classification	
						Wagon sample	Seed cotton after leaving stick remover	Feeder sample	Grade	Staple length
	Pounds	Min.	Sec.	Pounds per minute	Pounds per minute	Percent	Percent	Percent	Designation	1/32 inch
1-----	815	9	50	82.8	72.0	11.9	4.4	2.2	<sup>3</sup> LMSpt+	34.0
2-----	780	8	35	90.6	78.6					
3-----	655	6	30	100.8	87.6					
4-----	895	7	55	112.8	98.4					
										Percent

<sup>1</sup> Figures represent averages for 4 lots processed by the following simple machinery arrangement: Tower drier at 220° F., green-boll trap, 60-inch stick remover with cleaning-saw cylinders operating at 750 r. p. m. and extractor-feeders.

<sup>2</sup> As determined by Shirley Analyzer tests.

<sup>3</sup> LMSpt+ means Low Middling Spot plus.

TABLE 5.—The number of USDA-designed 60-inch stick removers required in a gin for best cleaning results

HAND- OR MACHINE-PICKED COTTON

(1,300–1,600 pounds per bale)

Bales ginned per hour (number)		Stick removers required	Permissible cotton input into stick removers
		Number	Pounds per minute
1 or 2-----		1	1–50
3 or 4-----		2	51–100
5 or 6-----		3	101–150
7 or 8-----		4	151–200

MACHINE-STRIPPED OR HAND-SNAPPED COTTON <sup>1</sup>

(up to 2,000 pounds per bale)

1-----	1	1–50
2 or 3-----	2	51–100
4 or 5-----	3	101–150
6-----	4	151–200

<sup>1</sup> In some areas 3,000 or more pounds of machine-stripped or hand-snapped cotton may be required to produce a 500-pound bale. When more than 2,000 pounds are required, the number of stick removers needed can be figured on the basis of 50 pounds per minute INPUT into the machine.

within the average range of nonlint (foreign-matter) content associated with Strict Low Middling (SLM) white grades. The 11.9-percent foreign-matter content of the wagon sample was reduced to 4.4 percent in the seed-cotton samples taken immediately after they left the stick remover, and to 2.2 percent in the feeder samples. Calculations show that in this test the stick-remover unit was 67.9 percent efficient in the total trash removed, most of which consisted of hulls and shale.

Although excellent cleaning results were obtained with the machine at both Stoneville and Chickasha, it was observed that excessive quantities of seed-cotton locks were being lost into the trash.

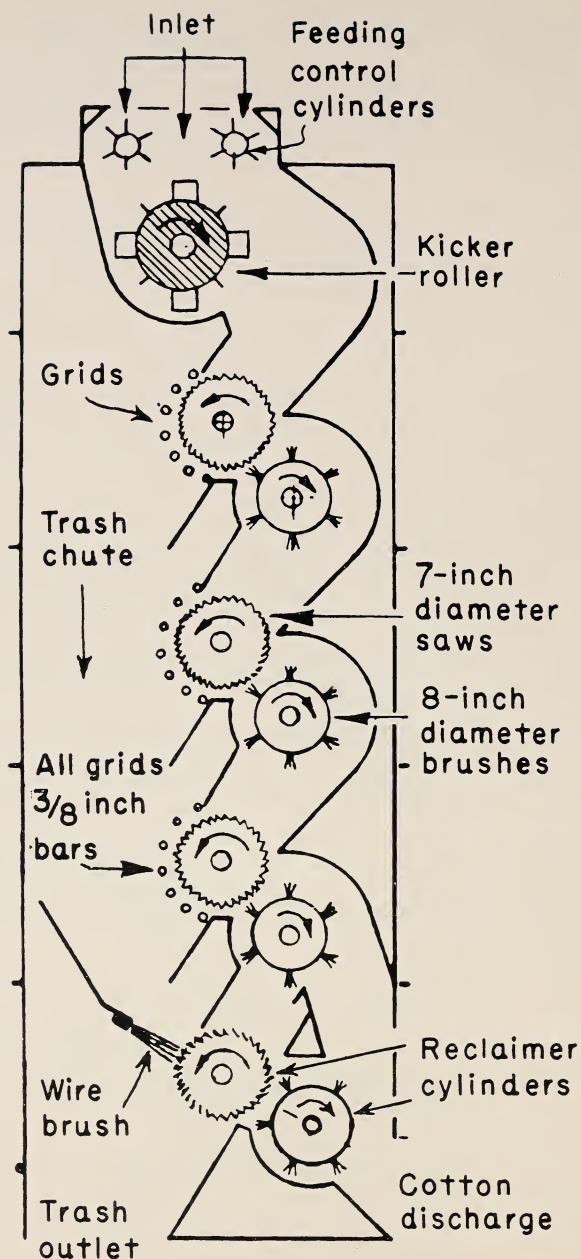
To overcome this undesirable tendency, efforts were again concentrated on the pilot model device, the objective being to reduce loss of seed cotton in the trash by incorporating a seed-cotton reclaiming cylinder in the machine. The fourth, or bottom, cleaning-saw cylinder of the 10-inch pilot model was converted into a reclaimer. The reclaiming cylinder itself had essentially the same construction as the cleaning-saw cylinders, except that it was operated at a lower speed. Also, instead of the cleaning grids, a 5-inch steel-wire reclaimer brush was situated adjacent to the saw cylinder and in an inclined position, to direct the seed cotton from the trash into the teeth of the reclaiming saw (fig. 11). A doffing brush was provided to doff the reclaimed seed cotton and direct it into the discharge passage with the cleaned seed cotton from the upper three cleaning-saw cylinders. Consistently satisfactory reclaiming and cleaning results were obtained in tests of the reclaimer on machine-stripped cotton. The results of the tests showed an average negligible seed-cotton loss of only 2.4 pounds per bale, or 0.12 percent (table 6).

After obtaining this information on the reclaimer, a test was run with the pilot model device in two replications to gain further information on the comparative cleaning effectiveness connected with the handling of seed cotton representing different types of harvesting.

TABLE 6.—*Trash-removal data and seed-cotton loss associated with processing six 25-pound lots of machine-stripped seed cotton through the 10-inch pilot-model stick remover equipped with 3 cleaning cylinders, followed by 1 reclaiming cylinder (crop of 1953)*

Lot No.	Foreign-matter content of seed cotton		Weight of seed cotton		Trash removed by stick remover	Quantity of seed cotton in trash	Total seed cotton lost per bale <sup>1</sup>	
	Wagon sample	After leaving stick remover	Before entering stick remover	After leaving stick remover				
	Percent	Percent	Pounds	Pounds	Pounds	Percent	Pounds	Percent
1-----	28.8	7.2	25.0	18.0	5.7	0.46	2.1	0.10
2-----	28.8	6.5	25.0	18.4	5.9	.53	2.5	.12
3-----	28.8	8.6	25.0	18.3	5.9	.38	1.8	.09
4-----	28.8	8.8	25.0	18.2	6.3	.46	2.3	.12
5-----	28.8	6.8	25.0	18.4	5.7	.63	2.9	.14
6-----	28.8	7.6	25.0	18.4	6.0	.58	2.8	.14
Average-----	28.8	7.6	25.0	18.3	5.9	.51	2.4	.12

<sup>1</sup> Calculated on the basis of 2,000 pounds of machine-stripped seed cotton per bale.



BN-6365

FIGURE 11.—Cross-section drawing of stick remover, showing reclaiming-saw cylinder and wire brush used to direct seed cotton from the trash into the teeth of the reclaiming saw.



Two lots each of 4 types of cotton were used, and the usual good cleaning results were obtained on all types, with overall trash removal of 80.0, 85.2, 72.1, and 78.6 percent for the late hand-picked, hand-snapped, machine-picked, and machine-stripped seed cottons, respectively.

## LABORATORY AND COMMERCIAL GIN TESTING

In the design, construction, and development of the stick remover, the aims and objectives of the project were to provide: (1) An apparatus of relatively simple construction without the intricate details and expensive shopwork required for a more complex machine; (2) a satisfactory method of introducing and delivering the seed cotton to and from the machine in a continuous flow; (3) a cleaning machine having sufficient capacity to handle adequately the variable quantities of seed cotton that would be required per unit without retarding ginning processes and without damage to the fiber; and (4) a trash chamber to receive and dispose of sticks, stems, and other foreign matter removed from the seed cotton by the cleaner with a minimum loss of seed cotton.

With the foregoing objectives in mind, attention was given to the final development and testing of the 60-inch gin-capacity machine. A careful check was made to determine the cleaning effectiveness of the stick remover with varied numbers of cleaning cylinders. Comparisons were made of the average test results of the final cleaning. These comparisons were based on the foreign-matter content of lint as well as the average trash removal when 1 to 5 cylinders were used. The findings justified the selection of 3-cylinder cleaning followed by the reclaimer as the most feasible combination from the standpoint of both mechanical requirements and cleaning-results. Cleaning-test results, obtained when 4 cylinders were followed by the reclaimer and another finishing-cleaning cylinder, indicated slight trash-removal advantages over the 3-cylinder cleaning; nevertheless, these tests revealed that the necessary increase in the bulk of the machine and other mechanical requirements would offset such cleaning advantages. In the final development stages, additional tests, conducted to check mechanical elements involved in the operation and capacity of the machine, confirmed the results of the tests already discussed.

## PRELIMINARY TESTS

Typical laboratory cleaning results, obtained in preliminary tests with the gin-capacity stick remover in handling machine-picked and machine-stripped cotton, with alternate use of  $\frac{7}{8}$ - and  $1\frac{3}{8}$ -inch grid spacings, are given (table 7).

The best all-round results were obtained on machine-stripped cotton with the  $1\frac{3}{8}$ -inch grid spacings, in which the stick remover showed trash-removal efficiency of 86 percent on hulls, 73.4 percent on sticks and stems, and 56.2 percent on leaf trash, or a total trash-removal efficiency of 82 percent. On the other hand, the best overall cleaning results on machine-picked cotton were obtained with the  $\frac{7}{8}$ -inch grid spacings, in which the stick remover showed trash-removal efficiency of 72.8 percent on hulls, 46.7 percent on sticks and stems, and 57.6 percent on leaf trash, with a total trash-removal efficiency of 62 percent.

TABLE 7.—*Trash-removal-efficiency results associated with cleaning machine-stripped and machine-picked cottons by the stick remover, using 7/8-inch and 1 3/8-inch grid-space openings*

7/8-INCH GRID-SPACE OPENINGS

Type of foreign matter	Machine-stripped cotton <sup>1</sup>				Machine-picked cotton <sup>2</sup>			
	Foreign matter content of wagon seed cotton		Foreign matter extracted by stick remover		Foreign matter content of wagon seed cotton		Foreign matter extracted by stick remover	
	<i>Pounds</i>	<i>Percent</i>	<i>Pounds</i>	<i>Percent</i>	<i>Pounds</i>	<i>Percent</i>	<i>Pounds</i>	<i>Percent</i>
Hulls-----	408. 0	20. 4	306. 4	75. 1	36. 2	2. 5	26. 4	72. 8
Sticks and stems-----	60. 0	3. 0	31. 1	51. 8	8. 7	. 6	4. 1	46. 7
Leaf and fine trash---	146. 0	7. 3	83. 8	57. 4	65. 2	4. 5	37. 6	57. 6
Motes-----			<sup>3</sup> 12. 2					
Total of all types--	614. 0	30. 7	433. 5	70. 6	110. 1	7. 6	68. 1	62. 0

1 3/8-INCH GRID-SPACE OPENINGS

	<i>Pounds</i>	<i>Percent</i>	<i>Pounds</i>	<i>Percent</i>	<i>Pounds</i>	<i>Percent</i>	<i>Pounds</i>	<i>Percent</i>
Hulls-----	408. 0	20. 4	350. 9	86. 0	36. 2	2. 5	31. 5	87. 0
Sticks and stems-----	60. 0	3. 0	44. 0	73. 4	8. 7	. 6	3. 3	38. 3
Leaf and fine trash---	146. 0	7. 3	82. 0	56. 2	65. 2	4. 5	25. 0	38. 4
Motes-----			<sup>3</sup> 26. 6					
Total of all types--	614. 0	30. 7	503. 5	82. 0	110. 1	7. 6	59. 8	54. 0

<sup>1</sup> Based on 2,000 pounds of machine-stripped cotton per bale. Figures represent averages of 7 test replications.

<sup>2</sup> Based on 1,450 pounds of machine-picked cotton per bale. Figures represent averages of 24 samples taken from 4 machine-picked cottons, with 6 test replications per cotton.

<sup>3</sup> In this test on machine-stripped cotton, the motes in the stick-remover trash were separated and weighed, but no measure was made of the motes in the seed-cotton wagon sample. No measure was made of the motes in the tests involving the machine-picked cotton.

On machine-picked cotton, the 1 3/8-inch grid spacings gave somewhat better hull removal than did the 7/8-inch spacings, from the standpoint of overall cleaning results; but this was offset by the significantly greater removal of sticks, stems, and leaf trash by the 7/8-inch spacings.

On the whole, grid spacings of 1 3/8 inches have proved most satisfactory for machine-stripped cotton, such as that handled in Oklahoma and other western areas, whereas the 7/8-inch spacings have proved to be optimum for machine-picked cotton in the Central and Southwestern States.

Throughout the entire period of research and development on the stick remover, appropriate samples of seed cotton, lint, and foreign matter were taken. The lint samples were classed and were subjected to fiber tests. Laboratory determinations were made of foreign-matter and moisture content, and spinning tests were performed on representative samples. The results of these tests played an important part in the development of the final stick remover.

## TESTS OF STICK REMOVER IN COMBINATION WITH OTHER CLEANING MACHINERY

Beginning in the fall of 1954, work was concentrated on a study of the stick remover in combination with conventional cleaning machines previously employed for most seed-cotton cleaning at gins. The study was designed to provide information on: (1) Mechanical operation and performance; (2) effects on nep count, fiber qualities, and spinning qualities; and (3) cleaning effectiveness.

A 60-inch stick remover with 3 cylinders and a reclaimer was installed in the 3-stand gin plant at the Stoneville (Miss.) laboratory. This was the model used in this study.

### Machine-Stripped and Machine-Picked Cotton

In the study of the stick remover in combination with other cleaning machines, 12 machinery combinations or arrangements, ranging from moderately simple to elaborate, were used on machine-stripped and machine-picked cottons. These combinations were:

1. Tower drier, 6-cylinder cleaner, bur machine, 7-cylinder revolving-screen cleaner, and extractor-feeder-cleaners.

2. Same as 1 with lint cleaners added.

3. Tower drier, 7-cylinder cleaner, stick remover, 7-cylinder revolving-screen cleaner, and extractor-feeder-cleaners.

4. Same as 3 with lint cleaners added.

5. Tower drier, 13-cylinder cleaner, stick remover, and extractor-feeder-cleaners.

6. Same as 5 with lint cleaners added.

7. Tower drier, stick remover, 7-cylinder revolving-screen cleaner, and extractor-feeder-cleaners.

8. Same as 7 with lint cleaners added.

9. Tower drier, 6-cylinder cleaner, bur machine, stick remover, 7-cylinder revolving-screen cleaner, and extractor-feeder-cleaners.

10. Same as 9 with lint cleaners added.

11. Tower drier, 7-cylinder cleaner, stick remover, bur machine, 7-cylinder revolving-screen cleaner, and extractor-feeder-cleaners.

12. Same as 11 with lint cleaners added.

These 12 cleaning-machinery combinations were used in 2 different series of tests on machine-stripped cotton with an average foreign-matter content of 32.5 percent, and on 2 series of machine-picked cotton with an average foreign-matter content of 5.5 percent. The tests were run in 6 replications, which made a total of 72 test lots for each of the 2 types of harvesting. The machine-stripped cotton for these tests was hauled from Alabama to the U. S. Cotton Ginning Research Laboratory at Stoneville, Miss., and the machine-picked cotton was supplied by the Delta Branch Experiment Station at Stoneville.<sup>3</sup>

A study of data on foreign-matter content of the feeder samples in this series of tests shows a trend of slightly higher average amounts

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<sup>3</sup> Appreciation is expressed to the leaders of the Cotton Mechanization Project at Stoneville, Miss., and Auburn, Ala., for their cooperation in supplying the cottons for these tests.



of foreign matter in combinations 7 and 8, in which the stick remover was not preceded by some cylinder cleaning. A study of the grade and staple-length results, however, shows no highly significant trend of differences in the cleaning combinations. A study of the foreign-matter content of the lint cotton, as determined by Shirley Analyzer tests, shows a decided, consistent trend of improvement associated with the six combinations in which lint cleaners were used (tables 8 and 9). This trend is also reflected in a higher average of grade indexes.

TABLE 8.—*Foreign-matter content and classification results associated with cleaning and ginning machine-stripped cotton by the indicated machinery combinations (crop of 1954)*<sup>1</sup>

Machinery combination used in cotton gin	Foreign-matter content of cotton			Classification data		
	Wagon sample	Feeder sample	Ginned lint <sup>2</sup>	Grade <sup>3</sup>		Staple length
1. Tower drier at 290° F., 6-cylinder cleaner, bur machine, 7-cylinder revolving-screen cleaner, extractor-feeder-cleaners.....	Percent 32. 5	Percent 3. 1	Percent 9. 11	Index 85. 8	Designation LM	½2 inch 31. 6
2. Same as 1 with lint cleaners added.....	32. 5	3. 6	7. 72	87. 8	LM+	31. 2
3. Tower drier at 290° F., 7-cylinder cleaner, stick remover, 7-cylinder revolving-screen cleaner, extractor-feeder-cleaners.....	32. 5	3. 4	9. 30	85. 6	LM	31. 6
4. Same as 3 with lint cleaners added.....	32. 5	3. 4	8. 41	87. 2	LM+	31. 4
5. Tower drier at 290° F., 13-cylinder cleaner, stick remover, extractor-feeder-cleaners.....	32. 5	2. 8	8. 44	86. 6	LM	31. 6
6. Same as 5 with lint cleaners added.....	32. 5	3. 4	8. 92	88. 2	LM+	31. 7
7. Tower drier at 290° F., stick remover, 7-cylinder revolving-screen cleaner, extractor-feeder-cleaners.....	32. 5	3. 8	10. 32	83. 1	LM—	31. 2
8. Same as 7 with lint cleaners added.....	32. 5	3. 9	8. 89	86. 7	LM	31. 6
9. Tower drier at 290° F., 6-cylinder cleaner, bur machine, stick remover, 7-cylinder revolving-screen cleaner, extractor-feeder-cleaners.....	32. 5	1. 6	8. 82	86. 6	LM	31. 4
10. Same as 9 with lint cleaners added.....	32. 5	2. 2	7. 60	88. 1	LM+	31. 8
11. Tower drier at 290° F., 7-cylinder cleaner, stick remover, bur machine, 7-cylinder revolving-screen cleaner, extractor-feeder-cleaners.....	32. 5	2. 4	8. 41	87. 0	LM	31. 2
12. Same as 11 with lint cleaners added.....	32. 5	2. 4	7. 52	88. 9	LM+	31. 5

<sup>1</sup> Figures represent averages of 6 replications. The seed-cotton wagon samples for this series of tests averaged 12.2 percent moisture content; the feeder samples, 9.8 percent; and the lint-cotton samples, 4.8 percent.

<sup>2</sup> As determined by Shirley Analyzer tests.

<sup>3</sup> 85=Low Middling (LM); 94=Strict Low Middling (SLM).

TABLE 9.—*Foreign-matter content and classification results associated with cleaning and ginning machine-picked cotton by the indicated gin machinery combinations (crop of 1954)*<sup>1</sup>

Machinery combination used in cotton gin	Foreign-matter content of cotton			Classification data		
	Wagon sample	Feeder sample	Ginned lint <sup>2</sup>	Grade <sup>3</sup>		Staple length
1. Tower drier at 290° F., 6-cylinder cleaner, bur machine, 7-cylinder revolving-screen cleaner, extractor-feeder-cleaners .....	<i>Percent</i> 5.5	<i>Percent</i> 1.2	<i>Percent</i> 6.11	<i>Index</i> 87.2	<i>Designation</i> LM+	<i>1/32 inch</i> 34.0
2. Same as 1 with lint cleaners added .....	5.5	1.1	4.90	89.6	SLM—	34.1
3. Tower drier at 290° F., 7-cylinder cleaner, stick remover, 7-cylinder revolving-screen cleaner, extractor-feeder-cleaners .....	5.5	1.4	5.97	86.5	LM	33.8
4. Same as 3 with lint cleaners added .....	5.5	1.4	5.02	88.0	LM+	34.1
5. Tower drier at 290° F., 13-cylinder cleaner, stick remover, extractor-feeder-cleaners .....	5.5	1.2	6.44	86.2	LM	33.9
6. Same as 5 with lint cleaners added .....	5.5	1.0	4.88	88.0	LM+	34.0
7. Tower drier at 290° F., stick remover, 7-cylinder revolving-screen cleaner, extractor-feeder-cleaners .....	5.5	1.5	7.16	85.4	LM	33.8
8. Same as 7 with lint cleaners added .....	5.5	1.6	5.40	87.4	LM+	34.0
9. Tower drier at 290° F., 6-cylinder cleaner, bur machine, stick remover, 7-cylinder revolving-screen cleaner, extractor-feeder-cleaners .....	5.5	1.0	5.73	87.0	LM+	33.8
10. Same as 9 with lint cleaners added .....	5.5	1.1	4.90	88.0	LM+	34.2
11. Tower drier at 290° F., 7-cylinder cleaner, stick remover, bur machine, 7-cylinder revolving-screen cleaner, extractor-feeder-cleaners .....	5.5	1.1	5.73	87.2	LM+	33.8
12. Same as 11 with lint cleaners added .....	5.5	1.0	5.29	88.0	LM+	33.8

<sup>1</sup> Figures represent averages of 6 replications. The seed-cotton wagon samples for this series of tests averaged 13.4 percent moisture content; the feeder samples, 10.6 percent and the lint samples, 3.4 percent.

<sup>2</sup> As determined by Shirley Analyzer tests.

<sup>3</sup> 85=Low Middling (LM) 94=Strict Low Middling (SLM).

A careful study of nep counts, by both the raw-stock and the conventional card-web method, and a study of the other fiber- and spinning-test results show no adverse effects on these quality factors resulting from the use of the stick remover (tables 10, 11, 12, and 13).

TABLE 10.—*Fiber-test results associated with cleaning and ginning machine-stripped cotton by the indicated machinery combinations (crop of 1954)*<sup>1</sup>

Machinery combination used in cotton gin	Fiber-test data				
	Upper half mean length (fibro-graph)	Mean length (fibro-graph)	Uniformity ratio	Tensile strength	Nep count by raw stock method <sup>2</sup>
	<i>Inches</i>	<i>Inches</i>	<i>Index</i>	<i>1,000 pounds per square inch</i>	<i>Number per 100 square inches of card web</i>
1. Tower drier at 290° F., 6-cylinder-cleaner, bur machine, 7-cylinder revolving-screen cleaner, extractor-feeder-cleaners.....	1. 00	0. 77	77	85	9
2. Same as 1 with lint cleaners added.....	. 99	. 80	80	84	11
3. Tower drier at 290° F., 7-cylinder cleaner, stick remover, 7-cylinder revolving-screen cleaner, extractor-feeder-cleaners.....	1. 00	. 78	78	85	10
4. Same as 3 with lint cleaners added.....	1. 00	. 78	78	84	12
5. Tower drier at 290° F., 13-cylinder cleaner, stick remover, extractor-feeder-cleaners.....	1. 00	. 80	80	82	10
6. Same as 5 with lint cleaners added.....	1. 01	. 79	78	84	11
7. Tower drier at 290° F., stick remover, 7-cylinder revolving-screen cleaner, extractor-feeder-cleaners.....	1. 01	. 81	80	85	8
8. Same as 7 with lint cleaners added.....	1. 00	. 78	78	83	9
9. Tower drier at 290° F., 6-cylinder cleaner, bur machine, stick remover, 7-cylinder revolving-screen cleaner, extractor-feeder-cleaners.....	1. 00	. 80	80	82	8
10. Same as 9 with lint cleaners added.....	1. 00	. 80	80	83	10
11. Tower drier at 290° F., 7-cylinder cleaner, stick remover, bur machine, 7-cylinder revolving-screen cleaner, extractor-feeder-cleaners.....	1. 00	. 80	80	82	10
12. Same as 11 with lint cleaners added.....	1. 00	. 80	80	81	10

<sup>1</sup> Figures represent averages of 6 replications.

<sup>2</sup> Raw-stock nep-count values: 10 and below=Low; 11 to 20=Average; 21 to 30=High; 31 and above=Very High.

It is noted that combinations 5 and 6—the moderately simple cleaning arrangements, in which the stick remover was preceded by 13 cylinders of cleaning—generally gave as good, or slightly better, all-round results than did some of the more elaborate cleaning arrangements.

### Clean Hand-Picked Cotton

The following 6 cleaning-machinery combinations were used in a series of tests on clean hand-picked cotton having a wagon-sample foreign-matter content of 1.8 percent:

1. Tower drier, 7-cylinder cleaner, and extractor-feeder-cleaners.
2. Same as 1 with lint cleaners added.
3. Tower drier, 7-cylinder cleaner, stick remover, and extractor-feeder-cleaners.
4. Same as 3 with lint cleaners added.
5. Tower drier, stick remover, and extractor-feeder-cleaners.
6. Same as 5 with lint cleaners added.



TABLE 11.—*Spinning-test results associated with cleaning and ginning machine-stripped cotton by the indicated machinery combinations (crop of 1954)*<sup>1</sup>

Machinery combinations used in cotton gin	Spinning-test data					
	Picker and card waste	Neps in card web <sup>2</sup>	Yarn strength		Yarn appearance <sup>3</sup>	
			22s	50s	22s	50s
		<i>Number per 100 square inches of card web</i>			<i>Code index</i>	<i>Code index</i>
1. Tower drier at 290° F., 6-cylinder cleaner, bur machine, 7-cylinder revolving-screen cleaner, extractor-feeder-cleaners.....	Percent 13. 8	17	Pounds 107. 4	Pounds 36. 7	100	80
2. Same as 1 with lint cleaners added.....	12. 7	18	107. 5	36. 6	100	80
3. Tower drier at 290° F., 7-cylinder cleaner, stick remover, 7-cylinder revolving-screen cleaner, extractor-feeder-cleaners.....	13. 8	14	107. 5	37. 4	105	80
4. Same as 3 with lint cleaners added.....	13. 4	18	107. 6	36. 2	95	80
5. Tower drier at 290° F., 13-cylinder cleaner, stick remover, extractor-feeder-cleaners.....	13. 6	14	109. 4	36. 6	100	80
6. Same as 5 with lint cleaners added.....	13. 6	19	110. 8	37. 3	100	80
7. Tower drier at 290° F., stick remover, 7-cylinder revolving screen cleaner, extractor-feeder-cleaners.....	14. 4	14	108. 6	36. 5	100	80
8. Same as 7 with lint cleaners added.....	13. 5	13	109. 0	37. 0	100	85
9. Tower drier at 290° F., 6-cylinder cleaner, bur machine, stick remover, 7-cylinder revolving-screen cleaner, extractor-feeder-cleaners.....	13. 6	16	107. 6	36. 0	100	85
10. Same as 9 with lint cleaners added.....	12. 4	16	109. 6	37. 2	100	80
11. Tower drier at 290° F., 7-cylinder cleaner, stick remover, bur machine, 7-cylinder revolving-screen cleaner, extractor-feeder-cleaners.....	13. 6	15	107. 6	36. 4	100	80
12. Same as 11 with lint cleaners added.....	13. 0	17	107. 6	35. 3	100	80

<sup>1</sup> Each figure represents the test results on 2 composite test lots, each of which was made up from 3 replicated samples.

<sup>2</sup> Card-web nep-count values: Below 16=Low; 16 to 25=Average; 26 to 40=High; above 40=Very High.

<sup>3</sup> Yarn-appearance code-index values: 100=Average (C+); 80=Poor (D+).

These tests were run in 3 replications, which made a total of 18 test lots in the series. The trend of results obtained in this series of tests on hand-picked cotton was essentially the same as for the machine-stripped and machine-picked cotton. Slightly higher grade in-

TABLE 12.—*Fiber-test results associated with cleaning and ginning machine-picked cotton by the indicated machinery combinations (crop of 1954)*<sup>1</sup>

Machinery combination used in cotton gin	Upper half mean length (fibro-graph)	Fiber-test data			
		Mean length (fibro-graph)	Uniformity ratio	Tensile strength	Nep count by raw stock method <sup>2</sup>
1. Tower drier at 290° F., 6-cylinder cleaner, bur machine, 7-cylinder revolving-screen cleaner, extractor-feeder-cleaners-----	<i>Inches</i> 0. 97	<i>Inches</i> 0. 70	<i>Index</i> 72	<i>1,000 pounds per square inch</i> 84	<i>Number per 100 square inches of card web</i> 12
2. Same as 1 with lint cleaners added-----	. 96	. 69	72	83	13
3. Tower drier at 290° F., 7-cylinder cleaner, stick remover, 7-cylinder revolving-screen cleaner, extractor-feeder-cleaners-----	. 98	. 71	73	84	14
4. Same as 3 with lint cleaners added-----	. 96	. 68	71	83	14
5. Tower drier at 290° F., 13-cylinder cleaner, stick remover, extractor-feeder-cleaners-----	. 98	. 71	72	85	12
6. Same as 5 with lint cleaners added-----	. 97	. 70	72	84	14
7. Tower drier at 290° F., stick remover, 7-cylinder revolving-screen cleaner, extractor-feeder-cleaners-----	. 96	. 70	72	85	13
8. Same as 7 with lint cleaners added-----	. 95	. 69	72	85	14
9. Tower drier at 290° F., 6-cylinder cleaner, bur machine, stick remover, 7-cylinder revolving-screen cleaner, extractor-feeder-cleaners-----	. 98	. 70	71	84	12
10. Same as 9 with lint cleaners added-----	. 98	. 70	72	85	14
11. Tower drier at 290° F., 7-cylinder cleaner, stick remover, bur machine, 7-cylinder revolving-screen cleaner, extractor-feeder-cleaners-----	. 98	. 70	72	85	17
12. Same as 11 with lint cleaners added-----	. 96	. 70	73	84	19

<sup>1</sup> Figures represent averages on 6 replications.

<sup>2</sup> Raw-stock nep-count values: 10 and below=Low; 11 to 20=Average; 21 to 30=High; 31 and above=Very High.

dexes and lower trash content in the feeder samples and ginned lint were associated with combinations 3 and 4, in which the stick remover was preceded by seven cylinders of cleaning. The use of the stick remover showed no adverse effects on staple length, nep count, or fiber and spinning quality (tables 14 and 15). The three arrangements in which the lint cleaners were used showed consistent improvements in the foreign-matter content of the lint and in higher grade indexes.

### Trash-Removal Efficiency

Three series of tests were run on machine-picked cotton, in which the stick remover was used in the following combination arrangement: 7-cylinder incline cleaner, stick remover, bur machine, 7-cylinder revolving-screen cleaner, and extractor-feeder-cleaner.

TABLE 13.—*Spinning-test results associated with cleaning and ginning machine-picked cotton by the indicated machinery combinations (crop of 1954)*<sup>1</sup>

Machinery combination used in cotton gin	Spinning-test data					
	Picker and card waste	Neps in card web <sup>2</sup>	Yarn strength		Yarn appearance <sup>3</sup>	
			22s	50s	22s	50s
1. Tower drier at 290° F., 6-cylinder cleaner, bur machine, 7-cylinder revolving-screen cleaner, extractor-feeder-cleaners.....	Percent 11.4	Number per 100 square inches of card web 20	Pounds 104.4	Pounds 35.2	Code index 95	Code index 80
2. Same as 1 with lint cleaners added.....	9.8	32	102.1	34.0	75	70
3. Tower drier at 290° F., 7-cylinder cleaner, stick remover, 7-cylinder revolving-screen cleaner, extractor-feeder-cleaners.....	11.4	22	102.8	34.8	90	75
4. Same as 3 with lint cleaners added.....	9.8	32	103.5	35.2	90	65
5. Tower drier at 290° F., 13-cylinder cleaner, stick remover, extractor-feeder-cleaners.....	11.0	28	105.5	35.7	95	75
6. Same as 5 with lint cleaners added.....	9.8	35	102.6	34.2	95	75
7. Tower drier at 290° F., stick remover, 7-cylinder revolving-screen cleaner, extractor-feeder-cleaners.....	11.8	26	101.4	34.2	95	70
8. Same as 7 with lint cleaners added.....	10.8	30	103.2	34.4	85	70
9. Tower drier at 290° F., 6-cylinder cleaner, bur machine, stick remover, 7-cylinder revolving-screen cleaner, extractor-feeder-cleaners.....	11.4	26	102.6	33.9	90	70
10. Same as 9 with lint cleaners added.....	10.0	27	105.4	36.0	90	75
11. Tower drier at 290° F., 7-cylinder cleaner, stick remover, bur machine, 7-cylinder revolving-screen cleaner, extractor-feeder-cleaners.....	11.8	26	103.6	35.2	90	70
12. Same as 11 with lint cleaners added.....	11.3	31	103.8	35.5	85	70

<sup>1</sup> Each figure represents the test results on 2 composite test lots, each of which was made up from 3 replicated samples.

<sup>2</sup> Card-web nep-count values: Below 16=Low; 16 to 25=Average; 26 to 40=High; above 40=Very High.

<sup>3</sup> Yarn-appearance code-index values: 100=Average (C+); 80=Poor (D+); 70=Very Poor (D); 60=Very Poor (Below Grade, BG).

Seed-cotton fractionation samples were taken before and after each machine, for the purpose of checking the progressive cleaning accomplished and determining the trash-removal efficiency of each machine when the equipment was arranged in this order. The total foreign-

TABLE 14.—*Foreign-matter content and classification and fiber-test results associated with cleaning and ginning hand-picked cotton by the indicated machinery combinations (crop of 1954)*<sup>1</sup>

Machinery combination used in gin	Foreign-matter content of cotton			Classification data		Fiber-test data					
	Wagon sample	Feeder sample	Ginned lint <sup>2</sup>	Grade <sup>3</sup>		Staple length	Upper half mean length (fibro-graph)	Mean length (fibro-graph)	Uni-formity ratio	Tensile strength	Nep count by raw stock method <sup>4</sup>
				Index	Designation						
1. Tower drier at 200° F., 7-cylinder cleaner, extractor-feeder-cleaners-----	Percent 1.8	Percent 0.7	Percent 3.77	101.2	M+	$\frac{1}{32}$ inch 34.3	Inches 1.05	Inches 0.83	Index 80	1,000 pounds per square inch 85	Number per 100 square inches of card web 10
2. Same as 1 with lint cleaners added-----	1.8	.6	3.59	102.3	SM-	34.5	1.05	.83	78	84	10
3. Tower drier at 200° F., 7-cylinder cleaner, stick remover, extractor-feeder-cleaners-----	1.8	.5	3.37	101.7	M+	34.5	1.05	.82	79	87	12
4. Same as 3 with lint cleaners added-----	1.8	.4	3.00	103.7	SM	34.2	1.06	.83	78	86	13
5. Tower drier at 200° F., stick remover extractor-feeder-cleaners-----	1.8	.5	4.35	100.7	M+	34.3	1.03	.81	78	87	10
6. Same as 5 with lint cleaners added-----	1.8	.5	3.51	101.0	M+	34.5	1.03	.80	77	84	13

<sup>1</sup> Figures represent averages of 3 replications. The seed-cotton wagon samples for this series of tests averaged 10.0 percent in moisture content; the feeder samples, 9.1 percent; and the lint samples, 5.5 percent.

<sup>2</sup> As determined by Shirley Analyzer tests.

<sup>3</sup> 100 = Middling (M); 104 = Strict Middling (SM).

<sup>4</sup> Raw-stock nep-count values: 10 and below = Low; 11 to 20 = Average; 21 to 30 = High; 31 and above = Very High.



TABLE 15.—*Spinning-test results associated with cleaning and ginning hand-picked cotton by the indicated machinery combinations (crop of 1954)*<sup>1</sup>

Machinery combinations used in gin	Spinning-test data					
	Picker and card waste	Neps in card web <sup>2</sup>	Yarn strength		Yarn appearance <sup>3</sup>	
			22s	50s	22s	50s
1. Tower drier at 200° F., 7-cylinder cleaner, extractor-feeder-cleaners.....	Percent 8.1	<i>Number per 100 square inches of web</i> 19	<i>Pounds</i> 113.7	<i>Pounds</i> 38.1	<i>Code index</i> 100	<i>Code index</i> 80
2. Same as 1 with lint cleaners added.....	8.0	20	110.5	37.6	100	80
3. Tower drier at 200° F., 7-cylinder cleaner, stick remover, extractor-feeder-cleaners.....	8.2	17	113.4	38.7	100	80
4. Same as 3 with lint cleaners added.....	8.0	16	112.5	38.2	100	80
5. Tower drier at 200° F., stick remover, extractor-feeder-cleaners.....	9.0	20	110.0	36.9	100	80
6. Same as 5 with lint cleaners added.....	8.4	23	110.0	36.9	100	80

<sup>1</sup> Each figure represents 1 composite test lot which was made up from 3 replicated samples.

<sup>2</sup> Card-web nep-count values: Below 16=Low; 16 to 25=Average; 26 to 40=High; above 40=Very High.

<sup>3</sup> Yarn-appearance code-index values; 100=Average (C+); 80=Poor (D+).

matter content of the 3 seed cottons used in these tests averaged 7.3 percent. The breakdown was: Hull content, 1.9 percent; sticks and stems, 1.0 percent; leaf and fine trash, 4.4 percent. The proportion of fine trash in this cotton ran high; and inasmuch as the 7-cylinder cleaner does its best on fine trash and had first chance at the cleaning, this machine ranked highest in cleaning, with an efficiency of 32.6 percent in overall trash removal (fig. 12 and table 16).

The stick remover ranked first in removal of sticks and stems, with an efficiency of 42.8 percent. The bur machine did its best work in the removal of hulls. The stick remover and the extractor-feeder-cleaner also did good work in hull removal, whereas the 7-cylinder cleaner and the 7-cylinder revolving-screen cleaner did good work in fine-trash removal. The overall trash-removal efficiency of all the machines combined amounted to 79.4 percent.

The results of these tests show that even though some machines outrank others in total trash removal, each machine makes a significant contribution toward attaining the end results.

The 7-cylinder cleaner, designed principally for leaf and fine-trash removal, is usually equipped with cleaning screens of about 2 by 2 mesh under the cylinders. The mesh in these screens restricts the size of particles of foreign matter that can be removed from the seed cotton. For this reason, it has been commonly believed that the

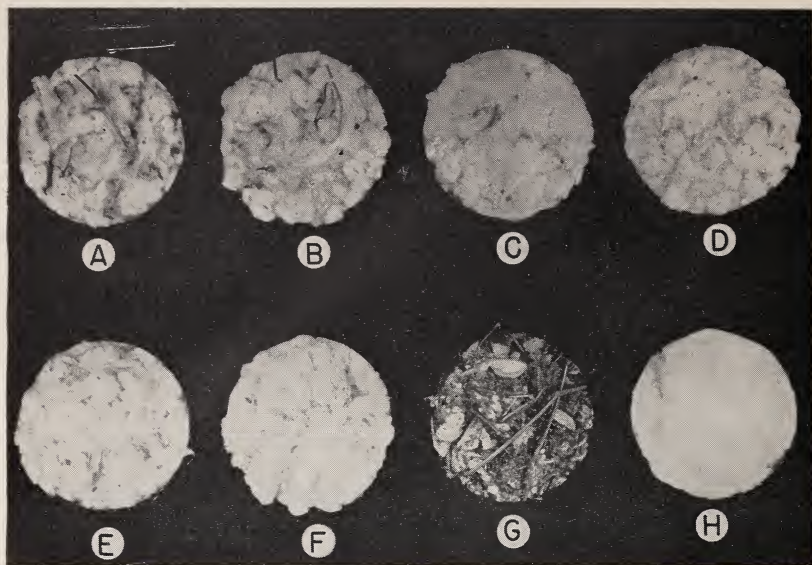


FIGURE 12.—Machine-picked cotton: *A*, Wagon sample; *B*, seed cotton after leaving tower drier and 7-cylinder cleaner; *C*, seed cotton after leaving tower drier, 7-cylinder cleaner, and stick remover with  $\frac{3}{8}$ -inch grid spacings; *D*, seed cotton after leaving tower drier, 7-cylinder cleaner, stick remover, and bur machine; *E*, seed cotton after leaving tower drier, 7-cylinder cleaner, stick remover, bur machine, stub tower, and 7-cylinder revolving-screen cleaner; *F*, same as *E* plus extractor-feeder-cleaner; *G*, stick-remover trash; *H*, ginned lint after *F* plus lint cleaners.

cylinder cleaner does almost nothing in the way of hull removal from seed cotton. This has seemed to be true because few hulls or hull fragments appear in the 7-cylinder trash in large enough size to be classified as hulls. Practically all the trash collected from the 7-cylinder cleaner has therefore been classified in the laboratory fractionation process as fine trash. The *trash* fractionation data have shown only negligible traces of hulls in the foreign matter that are classified as such.

On the other hand, fractionation of the seed cotton before and after cleaning has shown that substantial quantities of hulls are missing from the seed cotton after it has passed through the 7-cylinder cleaner. As this observation was based on test data, a further examination was made of available 7-cylinder cleaner trash from tests at the Stoneville laboratory, and also of cylinder trash samples collected in connection with a study at the Mesilla Park (N. Mex.) laboratory. This examination showed that small fragments of hulls, which were produced by the cleaning action of the 7-cylinder cleaner, were intermingled with the leaf or fine trash. It would have been difficult to make an accurate quantitative measurement of this material by separating it from the true fine leaf and dirt. Comparison of the hull content of the seed cotton before and after it passed through the cleaner, however, provided, a fairly accurate measurement of the hulls that were broken down and removed by the 7-cylinder cleaner.



TABLE 16.—*Trash-removal efficiency of the specified seed-cotton cleaning machines in handling machine-picked cotton, when used in combination and arranged in the successive order indicated by column headings from left to right (crop of 1955)*<sup>1</sup>

Type and quantity of foreign matter in wagon sample		Foreign-matter content of seed cotton as received, and proportion removed by the specified machines												
		7-cylinder cleaner		Stick remover		Bur machine		7-cylinder revolving-screen cleaner		Extractor-feeder-cleaner		Foreign matter removed by all machines combined	Final foreign-matter content at feeder apron	
Type	Quantity	As received	Proportion re- moved	As re- ceived	Proportion re- moved	As re- ceived	Proportion re- moved	As re- ceived	Proportion re- moved	As re- ceived	Proportion re- moved			
		Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent
		Hulls-----	1.9	26.3	1.4	50.0	0.7	57.1	0.3	0	0.3	66.7	94.7	0.1
		Sticks and stems-----	1.0	30.0	.7	42.8	.4	0	.4	0	.4	25.0	70.0	.3
	Leaf and fine trash-----	4.4	47.7	2.3	21.7	1.8	0	1.8	26.3	1.4	21.4	75.0	1.1	
	Total foreign matter removed (all types)-----	7.3	41.1	4.4	32.6	2.9	10.3	2.5	19.2	2.1	28.6	79.4	1.5	

<sup>1</sup> Figures represent averages of 27 samples taken from 3 machine-picked cottons with 9 replications per cotton.

## Mechanical Performance

The mechanical operation and performance of the stick remover in handling the machine-picked, machine-stripped, and hand-picked cotton in the laboratory gin was entirely satisfactory. The one 60-inch unit delivered sufficient cotton for the two 80-saw gin stands that were used in the series of tests.

In addition to the series of tests already reported, 14 full bale lots of very late-season, machine-picked cotton were run through the stick remover, to test the capacity of the machine and to serve as a general check on its mechanical performance. Good results were obtained in handling these bales.

Observations were made on the stick remover during the fall of 1954 at commercial gins in South Carolina, Louisiana, Mississippi, and Arkansas. The green-leaf problem encountered by cotton gins at Tupelo, Miss., and Sterlington, La., prompted the installation of the stick remover at gins at those locations. The machine gave excellent results in cleaning effectiveness and in mechanical operation and performance at these gins, and it proved that it had the stamina required for use day after day in a commercial gin (fig. 13).

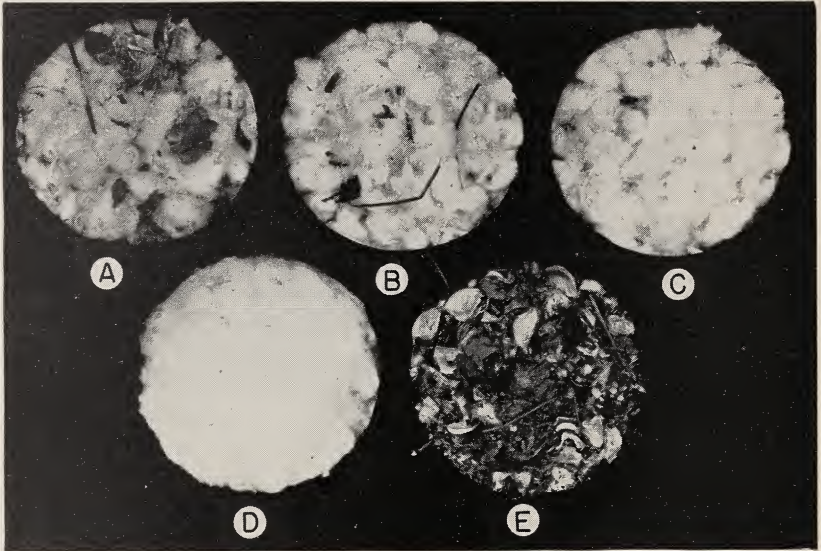


FIGURE 13.—Machine-picked cotton with heavy green-leaf content: A, Wagon sample; B, seed cotton after moderate cleaning without the stick remover; C, seed cotton with moderate cleaning plus the stick remover; D, ginned lint following C; E, trash extracted by the stick remover.

The rather extensive laboratory tests of the machine on cottons representing various types of harvesting, and in various combinations with other cleaning equipment ranging from simple to elaborate, showed that the stick remover is most effective when preceded by cylinder cleaning. From the standpoint of simplicity, best all-round results were obtained in these particular tests on machine-stripped and machine-picked cotton with a moderate cleaning-machinery combi-

nation consisting of a tower drier, a 13-cylinder cleaner, a stick remover, extractor-feeder-cleaners, and lint cleaners. These results indicated that the stick remover can serve well in doing the work equivalent to a bur machine and six or more cylinders of cleaning. In each instance, the use of the lint cleaners gave additional cleaning benefits.

These two machines—the lint cleaner and the stick remover, both of which were developed at the U. S. Cotton Ginning Research Laboratory—provide greatly improved cleaning at gins handling machine-picked and roughly hand-harvested cottons. In this respect, they excel any other machines developed since the practice of rough harvesting began to increase during World War II.

In the tests of hand-picked cotton, a machinery arrangement consisting of a tower drier, a 7-cylinder cleaner, a stick remover, extractor-feeder-cleaners, and lint cleaners gave the best cleaning results.

One of the most significant findings based on these test results is that the stick remover can be employed in combination with other cleaning machinery to provide more compact and economical cleaning arrangements in the modern cotton gin.

Tests have shown that the inclusion of the stick remover in the cleaning system of a cotton gin provides a slower buildup of sticks in the roll box. Accumulation of sticks in the seed rolls contributes to deterioration of cotton grade. This is because small particles are picked from the sticks by the saw teeth during ginning and entangled in the fiber. The use of the stick remover permits longer periods of gin-stand operation without roll dumping during the ginning of mechanically harvested cotton; and less dumping means the ginning of more bales per day.

## **COMPARISON WITH CLEANING MACHINES USED COMMERCIALY**

During the 1955-56 crop year, a special study was made on machine- and hand-picked cottons. In this study, the stick remover was used as an individual unit, with alternate use of  $\frac{7}{8}$ - and  $1\frac{3}{8}$ -inch grid-space openings, in comparison with the following 4 extracting and cleaning machines also used commercially:

- Bur machine
- 7-cylinder incline cleaner
- 7-cylinder revolving-screen cleaner
- Extractor-feeder-cleaner

Four machine-picked and three hand-picked cottons were used in these tests. For each cotton tested, 2 replicated lots were run for each machine, and 3 replicated wagon samples and 3 seed-cotton samples after cleaning were taken from each machine. The foreign-matter fractionation data from these samples supplied the data on trash-removal efficiency for each of the four individual machines.

### **Machine-Picked Cotton**

The results of the tests on machine-picked cotton show that the stick remover and the extractor-feeder-cleaner rank highest in overall trash removal, followed in order by the 7-cylinder incline cleaner, the bur machine, and the 7-cylinder revolving-screen cleaner. The overall

trash-removal efficiency of the stick remover with  $\frac{7}{8}$ -inch grid spacings was 62.0 percent, as compared with 37.6 percent for the 7-cylinder revolving-screen cleaner. The stick remover, when equipped with  $1\frac{3}{8}$ -inch grid spacings, ranked third in overall trash removal, with an efficiency of 54.0 percent, as compared with 62.0 percent for the same machine with  $\frac{7}{8}$ -inch grid spacings, and 60.2 percent for the extractor-feeder-cleaner (table 17).

TABLE 17.—*Foreign-matter-removal efficiency obtained with the designated individual machines in handling machine-picked cotton (crop of 1955)*<sup>1</sup>

Type and quantity of foreign matter in wagon sample		Proportion of foreign matter removed by the designated machines					
		Stick remover with—		Bur machine	7-cylinder incline cleaner	7-cylinder revolving-screen cleaner	Extractor-feeder-cleaner
Type	Quantity	$\frac{7}{8}$ -inch grids	$1\frac{3}{8}$ -inch grids				
	Percent	Percent	Percent	Percent	Percent	Percent	Percent
Hulls .....	2.5	72.8	87.0	71.1	38.6	21.5	85.4
Sticks and stems .....	.6	46.7	38.3	25.0	28.3	21.7	18.3
Leaf and fine trash .....	4.5	57.6	38.4	38.1	58.1	48.1	51.9
Total foreign matter removed (all types)---	7.6	62.0	54.0	47.9	49.3	37.6	60.2

<sup>1</sup> Figures represent averages of 24 samples taken from 4 machine-picked cottons with 6 replications per cotton.

In the removal of hulls from seed cotton, the stick remover with  $1\frac{3}{8}$ -inch grid spacings ranked first, with an efficiency of 87 percent. The extractor-feeder-cleaner ranked second with an efficiency of 85.4 percent, and the stick remover with  $\frac{7}{8}$ -inch grid spacings ranked third, with an efficiency of 72.8 percent. The bur machine also ranked high in hull removal, with an efficiency of 71.1 percent.

In the removal of sticks and stems, the stick remover with the  $\frac{7}{8}$ -inch grid spacings ranked first, with an efficiency of 46.7 percent. It ranked second when equipped with  $1\frac{3}{8}$ -inch grid spacings, with an efficiency of 38.3 percent. The 7-cylinder incline cleaner ranked third, with an efficiency of 28.3 percent in stick and stem removal. The bur machine, the 7-cylinder revolving-screen cleaner, and the extractor-feeder-cleaner ranked fourth, fifth, and sixth, respectively.

In the removal of leaf and fine trash from machine-picked cotton, the 7-cylinder incline cleaner ranked first with an efficiency of 58.1 percent, followed closely by the stick remover in second place with an efficiency of 57.6 percent. The extractor-feeder-cleaner and the 7-cylinder revolving-screen cleaner also ranked high in fine-trash removal, with the extractor-feeder-cleaner in third place with an efficiency of 51.9 percent, and the 7-cylinder revolving-screen cleaner in fourth place with an efficiency of 48.1 percent (see table 17 and fig. 14).

After the machine-picked seed cotton was sampled, following cleaning by the individual cleaning machines, it was passed on through the extractor-feeder-cleaner and ginned. Seed-cotton samples were then also drawn at the feeder apron immediately before ginning, to deter-



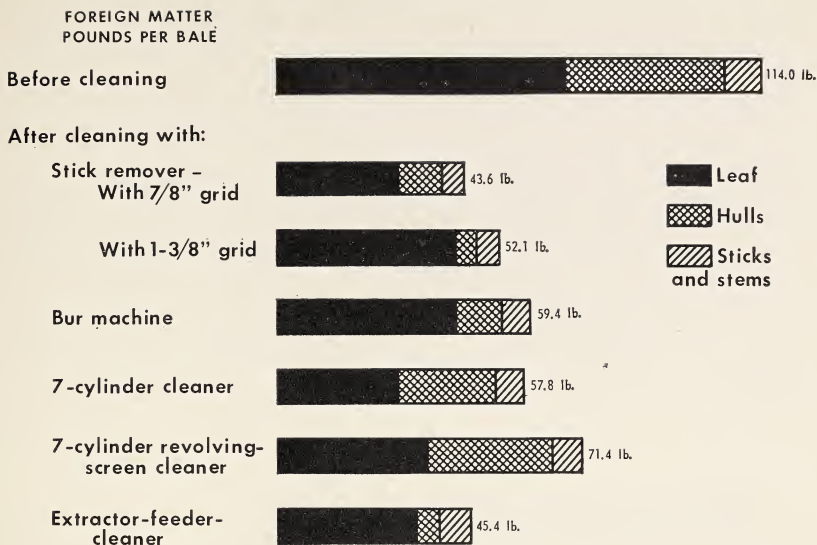


FIGURE 14.—Foreign-matter content of machine-picked cotton before cleaning and after cleaning with different machines.

mine the cleaning efficiencies associated with the various cleaning units when used in combination with the extractor-feeder-cleaner. Appropriate samples of lint cotton were also drawn for classification and for Shirley Analyzer tests.

The use of the extractor-feeder-cleaner after each machine tended to narrow the differences in efficiencies between the individual cleaning machines (table 18). In analyzing the final cleaning results obtained with the machines in combination with the extractor-feeder-cleaner, it is noted that in overall cleaning efficiency the stick remover with the 7/8-inch grid spacings again took first place with an efficiency of 76.4 percent; this was followed closely by the 7-cylinder incline cleaner taking second place with an efficiency of 75.0 percent; the bur machine taking third place with an efficiency of 74.8 percent, and the extractor-feeder-cleaner taking fourth place with an efficiency of 73.0 percent. The stick remover with 1 3/8-inch grid spacings and the 7-cylinder revolving-screen cleaner were tied for fifth place with an efficiency of 71.3 percent (table 18).

In analyzing the classification data and the results of the Shirley Analyzer tests (table 19), it is observed that the highest grade-index figures and the lowest foreign-matter-content figures for the lint samples were definitely correlated on a relative basis. The final overall seed-cotton-cleaning efficiencies of the three highest ranking machines were as follows: The stick remover with 7/8-inch grid spacings in combination with the extractor-feeder-cleaner ranked first, with an overall efficiency of 76.4 percent, a grade index of 87.3, and the lowest foreign-matter content in the lint (6.11 percent). The 7-cylinder incline-cleaner combination with the extractor-feeder-cleaner ranked second, with a total trash-removal efficiency of 75.0 percent, a grade index of 87.2, and a lint-cotton foreign-matter content of 6.49 per-

TABLE 18.—*Foreign-matter-removal efficiency results obtained in cleaning machine-picked cotton with the designated machines in combination with the extractor-feeder-cleaner (crop of 1955)*<sup>1</sup>

Type of foreign matter	Quantity of foreign matter in wagon sample	Foreign matter removed by—					
		Stick remover with ½-inch grids followed by extractor-feeder-cleaner	Stick remover with 1¾-inch grids followed by extractor-feeder-cleaner	Bur machine and extractor-feeder-cleaner	7-cylinder incline cleaner and extractor-feeder-cleaner	7-cylinder revolving-screen cleaner and extractor-feeder-cleaner	Extractor-feeder-cleaner (used twice)
Hulls-----	Percent 2.5	Percent 95.1	Percent 98.0	Percent 98.8	Percent 93.9	Percent 89.8	Percent 98.4
Sticks and stems-----	.6	48.3	53.3	45.0	41.7	40.0	41.7
Leaf and fine trash----	4.5	69.8	59.4	65.8	69.2	65.8	63.4
Total foreign matter removed (all types)-----	7.6	76.4	71.3	74.8	75.0	71.3	73.0

<sup>1</sup> Figures are averages of 24 samples taken from 4 machine-picked cottons with 6 replications per cotton.

cent. The bur machine, combined with the extractor-feeder-cleaner, ranked third, with a total trash-removal efficiency of 74.8 percent, a grade index of 86.1, and a lint-cotton foreign-matter content of 6.70 percent (see tables 18 and 19).

TABLE 19.—*Foreign-matter content, moisture content, and classification results associated with cleaning and ginning machine-picked cotton by the indicated machinery combinations (crop of 1955)*<sup>1</sup>

Cleaning-machinery combination	Foreign-matter content <sup>2</sup>	Moisture content <sup>3</sup>		Classification data		
		Feeder sample	Lint sample	Grade <sup>4</sup>	Staple length	
1. ½-inch stick remover and extractor-feeder-cleaner-----	Percent 6.11	Percent 7.4	Percent 3.4	Designation LM+	Code index 87.3	½2 inch 34.0
2. 1¾-inch stick remover and extractor-feeder-cleaner-----	7.69	7.2	3.5	LM	83.7	34.0
3. Bur machine and extractor-feeder-cleaner-----	6.70	7.4	3.8	LM	86.1	34.0
4. 7-cylinder incline cleaner and extractor-feeder-cleaner-----	6.49	7.7	3.7	LM+	87.2	34.0
5. 7-cylinder revolving-screen cleaner and extractor-feeder-cleaner----	7.14	8.2	3.8	LM	84.8	34.0
6. Extractor-feeder-cleaner (used twice)-----	7.67	7.3	4.4	LM	84.4	34.1

<sup>1</sup> Figures are averages of 16 samples taken from 4 machine-picked cottons with 4 replications per cotton.

<sup>2</sup> As determined by Shirley Analyzer tests.

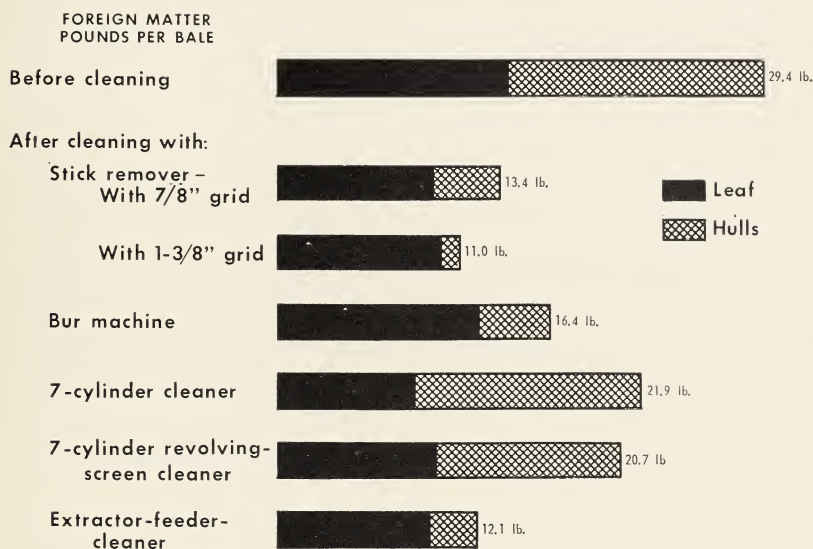
<sup>3</sup> The wagon-sample moisture content for these cottons averaged 10 percent. The average drier temperature used in processing these cottons was 269° F.

<sup>4</sup> 85=Low Middling (LM); 94=Strict Low Middling (SLM).

## Hand-Picked Cotton

The same type of tests, involving the same machines and machine combinations that were used on the machined-picked cottons, were also used on comparatively clean hand-picked cottons.

In analyzing the results of fractionation tests on the hand-picked seed-cotton samples, which were taken immediately after cleaning by the individual machines, the following overall cleaning-efficiency ranks were obtained: The stick remover with  $1\frac{3}{8}$ -inch grid spacings ranked first with an efficiency of 62.2 percent; the extractor-feeder-cleaner ranked second with an efficiency of 60.2 percent; the stick remover with  $\frac{7}{8}$ -inch grid spacings ranked third with an efficiency of 54.1 percent; the bur machine ranked fourth with an efficiency of 43.9 percent; the 7-cylinder revolving-screen cleaner ranked fifth with an efficiency of 30.1 percent; and the 7-cylinder incline cleaner ranked sixth with an efficiency of 26.5 percent. (See table 20 and fig. 15.)



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FIGURE 15.—Foreign-matter content of hand-picked cotton before cleaning and after cleaning with different machines.

The use of the extractor-feeder-cleaner following each machine tended to narrow the differences between the results obtained by the individual machines in cleaning hand-picked cotton, just as in cleaning machine-picked cotton (see table 19). In analyzing the final cleaning results obtained on hand-picked cotton with the machines in combination with the extractor-feeder-cleaner, it is noted that in overall cleaning efficiency, the stick remover with  $1\frac{3}{8}$ -inch grid spacings again took first place with an efficiency of 76.0 percent; the extractor-feeder-cleaner kept second place with an efficiency of 69.9 percent; and the stick remover with  $\frac{7}{8}$ -inch grid spacings continued

TABLE 20.—Average foreign-matter-removal efficiency obtained with the designated individual machines in handling hand-picked cotton (crop of 1955) <sup>1</sup>

Type and quantity of foreign matter in wagon sample <sup>2</sup>		Proportion of foreign matter removed by the designated machines					
Type	Quantity	Stick remover with—		Bur machine	7-cylinder incline cleaner	7-cylinder revolving-screen cleaner	Extractor-feeder-cleaner
		¾-inch grids	1¾-inch grids				
Hulls-----	Percent 1. 04	Percent 73. 8	Percent 92. 2	Percent 72. 8	Percent 12. 6	Percent 29. 1	Percent 81. 6
Leaf and fine trash-----	. 92	32. 6	29. 3	12. 0	40. 2	30. 4	33. 7
Total foreign matter removed (both types)-----	1. 96	54. 1	62. 2	43. 9	26. 5	30. 1	60. 2

<sup>1</sup> Figures represent averages of 18 samples taken from 3 hand-picked cottons with 6 replications per cotton.

<sup>2</sup> This comparatively clean, hand-picked cotton contained no sticks or stems.

in third place with an overall trash-removal efficiency of 62.2 percent. The 7-cylinder incline cleaner moved into fourth place with an efficiency of 57.1 percent; the 7-cylinder revolving-screen cleaner took fifth place with an efficiency of 55.6 percent; and the bur machine was in sixth place with an efficiency of 54.6 percent. (See table 21.)

In analyzing the classification data and the results of the Shirley Analyzer tests on hand-picked cotton, it is observed that the 4 highest

TABLE 21.—Foreign-matter-removal efficiency results obtained in cleaning hand-picked cotton with the designated machines in combination with the extractor-feeder-cleaner, as indicated (crop of 1955) <sup>1</sup>

Type and quantity of foreign matter in wagon sample <sup>2</sup>		Proportion of foreign matter removed by the indicated machine combinations:					
Type	Quantity	Stick-remover with ¾-inch grids, followed by extractor-feeder-cleaners	Stick-remover with 1¾-inch grids, followed by extractor-feeder-cleaner	Bur machine and extractor-feeder-cleaner	7-cylinder incline cleaner and extractor-feeder-cleaner	7-cylinder revolving screen cleaner and extractor-feeder-cleaner	Extractor-feeder-cleaner (twice)
		Percent	Percent	Percent	Percent	Percent	Percent
Hulls-----	1. 04	84. 6	98. 1	87. 5	64. 4	67. 3	90. 4
Leaf and fine trash-----	. 92	38. 0	52. 2	21. 7	48. 9	42. 4	48. 9
Total foreign matter removed (both types)-----	1. 96	62. 2	76. 0	54. 6	57. 1	55. 6	69. 9

<sup>1</sup> Figures are averages of 18 samples taken from 3 hand-picked cottons with 6 replications per cotton.

<sup>2</sup> This comparatively clean, hand-picked cotton contained no sticks or stems.



grade index figures and the corresponding lowest foreign-matter-content figures for the lint samples are associated with the 4 machines ranking highest in overall cleaning efficiency, as follows: The stick remover with 1½-inch grid spacing ranked first; the extractor-feeder-cleaner, second; the stick remover with 7⁄8-inch grid spacings, third; and the 7-cylinder incline cleaner, fourth. (See table 22.)

TABLE 22.—*Foreign-matter content, moisture content, and classification results associated with cleaning and ginning hand-picked cotton by the indicated machinery combinations (crop of 1955)*<sup>1</sup>

Cleaning-machinery combination	Foreign-matter content <sup>2</sup>	Moisture content <sup>3</sup>		Classification data		
		Feeder sample	Lint sample	Grade <sup>4</sup>	Staple length	
	Percent	Percent	Percent	Designation	Code index	½ inch
1. 7⁄8-inch stick remover and extractor-feeder-cleaner.....	3. 66	7. 8	4. 0	M+	100. 6	34. 1
2. 1½-inch stick remover and extractor-feeder-cleaner.....	3. 65	7. 3	4. 2	M+	100. 7	34. 1
3. Bur machine and extractor-feeder-cleaner.....	3. 89	8. 5	4. 4	M	99. 7	34. 0
4. 7-cylinder incline cleaner and extractor-feeder-cleaner.....	3. 70	7. 7	4. 2	M+	100. 8	34. 0
5. 7-cylinder revolving-screen cleaner and extractor-feeder-cleaner.....	4. 11	7. 5	4. 0	M	100. 2	34. 1
6. Extractor-feeder-cleaner (used twice).....	3. 71	7. 4	4. 4	M+	100. 7	34. 2

<sup>1</sup> Figures are averages of 12 samples taken from 3 hand-picked cottons with 4 replications per cotton.

<sup>2</sup> As determined by Shirley Analyzer tests.

<sup>3</sup> The wagon-sample moisture content for these cottons averaged 10 percent. The average drier temperature used in processing these cottons was 228° F.

<sup>4</sup> 100=Middling (M); 104=Strict Middling (SM).

In considering the cleaning effectiveness of the stick remover in comparison with other cleaning and extracting equipment, it should be emphasized that even though some machines outrank others in total trash removal, each type of commercial cleaning unit has been designed to do its best work on certain types of trash. Each machine, therefore, when used in combination with other machines in a gin cleaning system, may contribute to the attainment of the desired end results.

## MODIFICATIONS

In March 1956, modifications were made in the reclaimer section of the stick remover; and in early 1957, modifications were made in the contour of the brush scrolls.

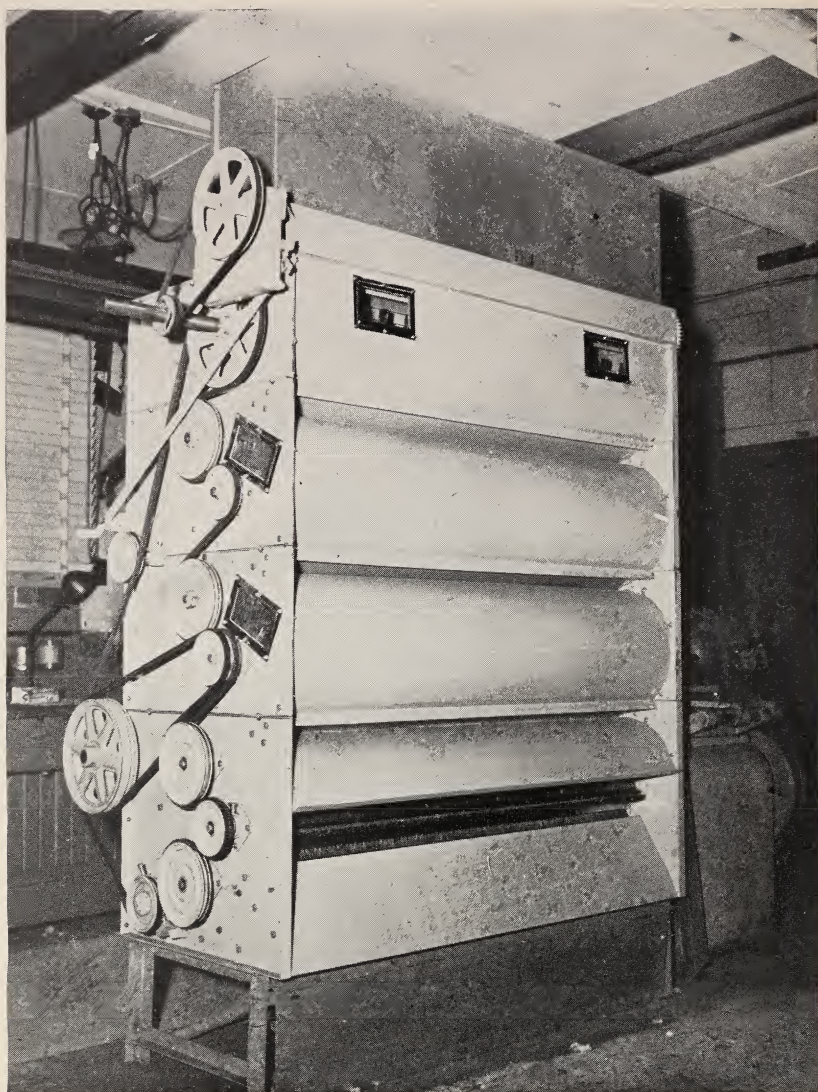


FIGURE 16.—The modified stick remover with only one doffing brush in reclaimer section.

The change in the reclaimer section served to eliminate one doffing brush. In the modified form, the reclaimer section is so equipped that the last cleaning-saw cylinder and the reclaiming-saw cylinder are doffed with the same doffing brush. The earlier model required a separate doffing brush for each saw cylinder. When this change was made, cleaning grids were installed for use in conjunction with the reclaiming-saw cylinder, in somewhat the same way that they were used in the early stages of development of the pilot-model machine. The use of only 1 doffing brush in the reclaimer section proved to be satisfactory during the 1956-57 ginning season, when 4 "Papoose"<sup>4</sup> stick removers in a commercial gin handled a seasonal volume of more than 4,000 bales.

The brush scrolls were modified so as to feed the seed cotton onto the saws at a point nearer the upper periphery of the saw cylinder. This was done to lessen the force of the saw contact with the seed cotton, thereby insuring a smoother and more direct flow of cotton through the machine.

The modifications in the stick remover have reduced the height of the machine by about 17 inches. This reduction in height should facilitate installation where overhead space is limited (see figs. 2 and 16).

## CONCLUSIONS

Comprehensive tests with the USDA-developed stick remover have proved this seed-cotton cleaning machine to be superior to any conventional cleaning machine used today for removing sticks and stems. The sling-off grid principle used in this device is very effective in all-round trash removal, and the test results place the stick remover in top rank with respect to the aggregate cleaning efficiency. The machine does an extra good job in the removal of hulls and leaf trash as well as sticks and stems, without adverse effects on fiber or spinning quality and with no increase in the number of neps in the ginned lint.

The stick remover can be employed in combination with other cleaning machinery to provide more compact and economical cleaning arrangements in the modern cotton gin.

The inclusion of the stick remover in the cleaning system of a cotton gin provides a slower buildup of sticks in the roll box. This permits longer periods of gin-stand operation without roll dumping when mechanically harvested cotton is ginned; and less dumping means more bales ginned per day. This also serves to prevent the lowering of cotton grade which occurs when sticks are present in the seed rolls: the saws nick particles from these sticks, and the particles in turn become entangled in the fiber.

<sup>4</sup> The name "Papoose" was given by the United States Cotton Ginning Research Laboratory, Stoneville, Miss., to the adaptation of the stick remover when used attached to the back of the extractor-feeder-cleaner.







